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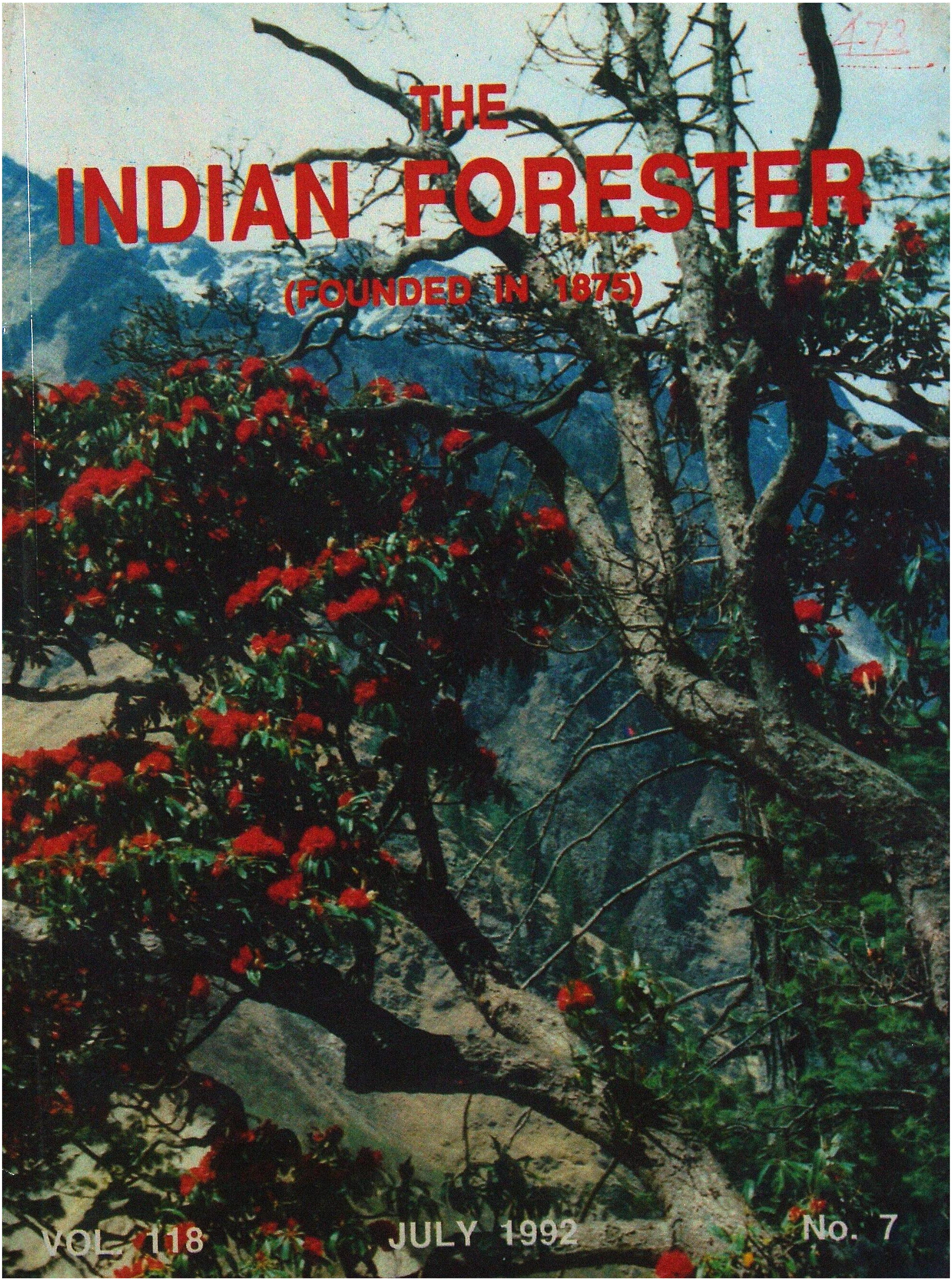

VOL. 118 JULY 1992 No. 7

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Lib No. 473

8-SEP 1992

ISSN 0019-4816

THE INDIAN FORESTER

Volume 118 No. 7

JULY, 1992

FRONT COVER

STRUGGLE FOR EXISTENCE (*RHODODENDRON ARBOREUM*) NEAR GANGNANI, UTTARKASHI FOREST DIVISION, UTTARKASHI (U.P.).

Photo—M.P. Singh

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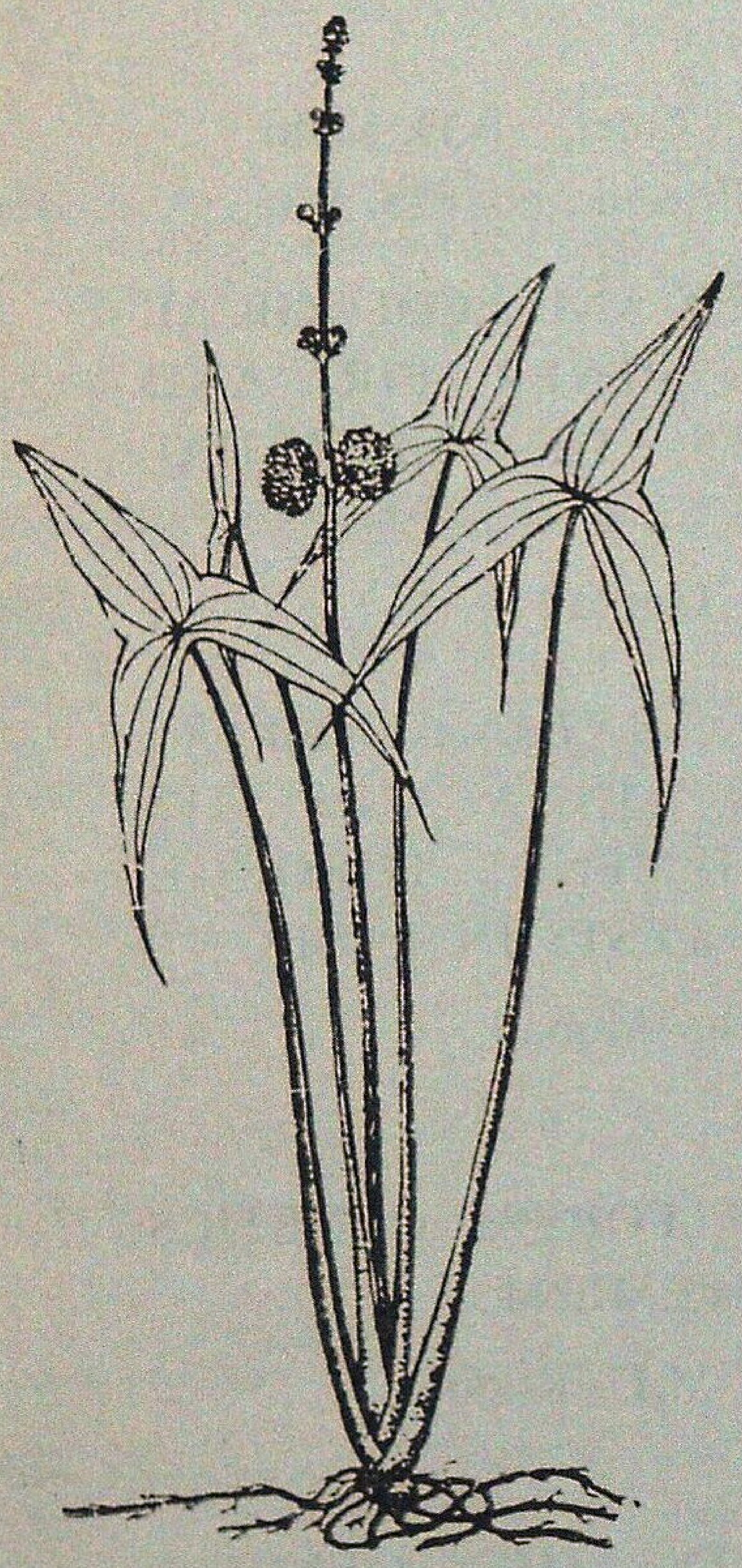

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PEOPLE'S PARTICIPATION IN FOREST MANAGEMENT

S. PALIT*

Introduction

Joint Forest Management or Participatory Forest Management is a comparatively new concept in Forestry, although a beginning was made through Social Forestry Projects. But in Social Forestry, such activities were more or less confined to areas outside the forests. Although the experimentations along this line in West Bengal began some 20 years ago, they remained isolated cases with little effect on forest management. Towards the second half of the last decade concerted efforts were made in South-West Bengal to give shape to this concept. As a result of which dozens of community based Forest Protection Committees started functioning. As on to-day the number of such Village Forest Protection Committees functioning in West Bengal is over 1971 covering 3,20,000 ha of forests.

Participatory Forest Management

By definition it would mean involving people in the decision making process in the management of forests. In West Bengal for preventing continuing degradation of the forests and for enhancing productivity an IDA assisted project is being launched with its protection strategy based on joint management arrangements with local communities.

A Historical Necessity

Forests in the country in most cases passed through three stages of management—traditional management under private ownership; no management and then finally Government management.

The forests suffered under private management because with rare exception the forests either served as an Agricultural Reserve, or purely as a source of revenue, or as a game reserve. The rapid degradation of forests under private management led to its takeover by the Government by declaring them as protected and reserved forests. The State take over had a fairly long gestation period, during which the forests passed through a 'no management' period with the degradation processes attaining an unprecedented scale.

Under Government management although the things started looking up for a while, the efforts could not be sustained. The basic reasons being an anomalous policy environment, lack of institutional capacity of forest organisation, burgeoning population, lack of productivity of both forest and agricultural lands, rural poverty, etc.

In conventional forest management, man is seldom if ever recognised as a component of forest eco-systems except to the extent he impinges on the forests; which in forestry parlance is termed *biotic interference*. This had to be minimised if not altogether eliminated to keep the forests out of the harm's way. Forest management tended to ignore

* Chief Conservator of Forests, Social Forestry, Calcutta (West Bengal).

human factor. The basic contradiction in the policy adopted earlier was, while its primary objective was the welfare of the people, it was not adequately responsive to the needs of the communities living in the fringes, who essentially depend on the forests for their existence. Whether or not Forest Department could have moulded the policy to make it more responsive to the community needs may be a matter of controversy, but the fact remains, something should have been done towards this direction much earlier,

The State of economy of these fringe dwelling communities depends in a major way on the health of the forests and they can be easily made to perceive this. National Forest Policy 1988 has however, not kept the matter vague. It has clearly laid down as one of its basic objectives—"Meeting the requirements of fuelwood, fodder, minor forest produce and small timber of the rural and tribal populations".

Not only this, it has been put as a high priority item even above-"essential national needs". Thus we have at last come to a realisation that fringe people should be recognised as a part of the forest eco-system and their need should be treated as the first charge on the forests. There is, therefore, absolutely no reason why a participatory management system cannot be successfully developed.

The Thrust Area

The thrust area should be to prevent continuing degradation of the forests and to reduce demand and supply imbalances by increasing productivity of the forests. In a developing nation like India we have to work under a capital crunch situation in general. Because of other social priorities the forestry sector is likely to remain under a resource crunch situation for quite sometime to come. From the various studies undertaken in the country and especially in West Bengal it has been clear that degraded forests with natural regeneration offers the best area of investment with the widest benefit to the country and the people. The investment per hectare of forests will be the lowest in this.

Even with a normal growth of population the demand-supply gap will go on increasing, generating stress, unless productivity of the forests is correspondingly increased. Apart from resuscitation of the degraded forest areas, the next important activity would be to go in for high input-high output production system to meet specific demands of industrial and other sectors.

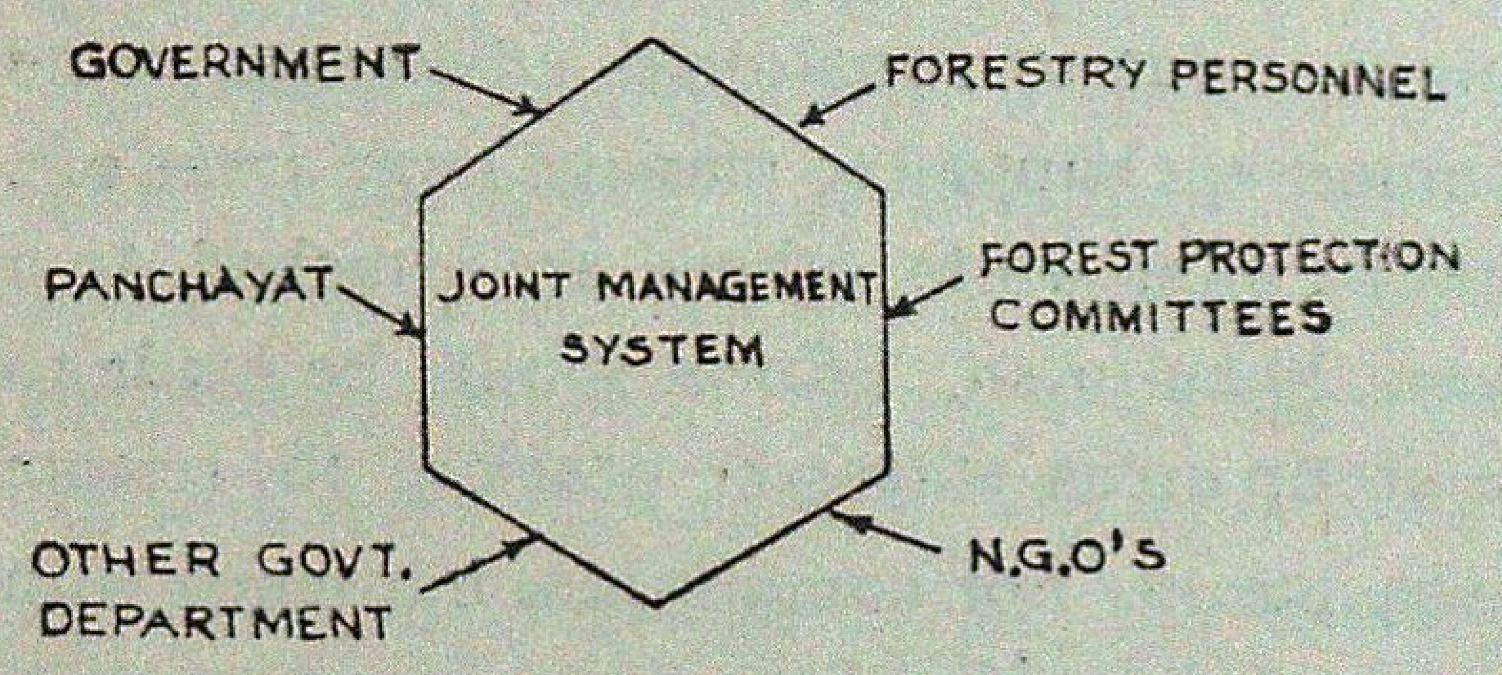
Communication and Awareness

The country as a whole has more or less been involved in implementation of Social Forestry Projects over the last decade or so. Social Forestry, therefore, has been a major element in the forest management. This has ushered in an era of collaborative management with the local communities. It has been possible to bring village people formally into the management system and a lot of awareness has already been created.

Through communication comes awareness. Joint management of forests, natural or artificial however is a new element for which a communication system has to be built up. Communication consists of all the processes by which information is transmitted and received. The subject matter may include - facts, intention, attitudes, etc. A communication is not complete unless it is received and understood. The usual result of

the understanding is a change in the behaviour. A joint management system may consist of several agencies and institutions but will not come to life unless communications effectively link all these parts together and co-ordinate their activities. Communication may be formal or informal but it must be two way.

Fig. 1



Joint Management of Forestry

Attitudinal changes

This includes the policy changes discussed earlier at the National level and at the State level. Then comes the attitudinal changes in the administrative echelons. This should be top down and may not be easy. Short orientation courses organised with the help of Non-Government Organisations may bring in the desired changes quickly. At the grass-roots level the same can be comprehensively effected through orientation-cum-micro-planning exercises.

Forest Protection Committee Formation

This is one item which should be primarily handled by forestry personnel. This involves some major decisions as to whether the Forest Protection Committees should at all be formed. If so, what are the priority areas; what should be the composition, etc. This is especially necessary because such actions besides having long term administrative implications will also determine the future of the forests.

The other implication is that foresters who have hitherto been used to a role of custodial policing have virtually lost all credence with the communities. This direct approach to the people in a new role will establish their credibility as a public servant very quickly. This will also generate an a mosphere of mutual trust and confidence which is considered very vital for sustainability of the system.

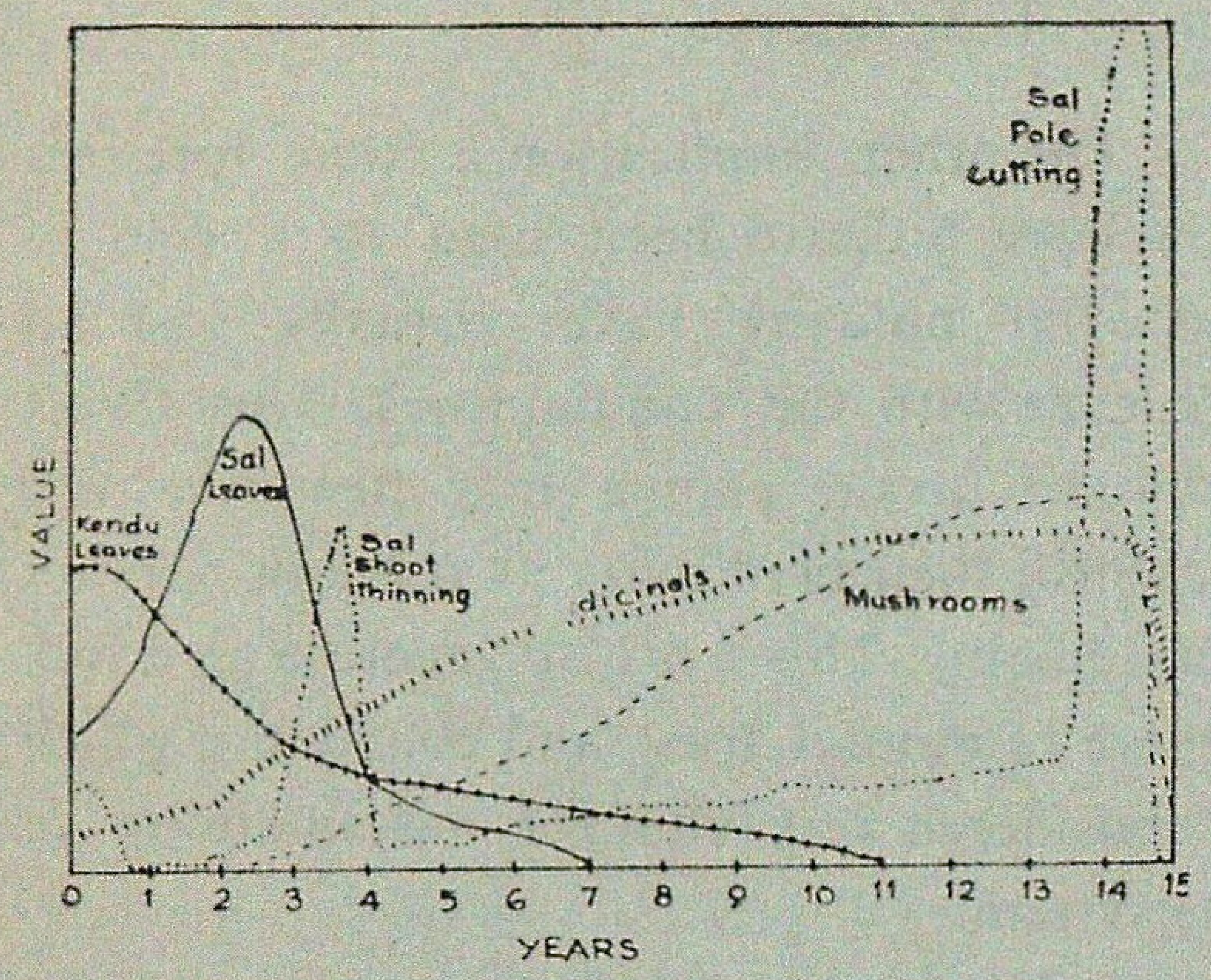
Composition and Character of the Forest Protection Committees : West Bengal experience shows a single village committee with representation from every household is the best. The cohesiveness, unerstanding, etc. start declining if the number exceeds three. From every household a joint membership of the husband and wife is likely settle the gender issues satisfactorily. A separate women's forum may be thought of as an additionality.

Ethnicity is another important factor. Pure ethnicity works better than a mixed one. Tribal groups by and large function better as Forest Protection Committees. The character and comosition of the forests may make the task difficult or easy. Around a coppice sal forest, the Forest Protection Committees can be quickly formed as the flow of benefits is not only substantial but also fairly even. For other kinds of forests or plantations, intermediate flow of benefits may have to be ensured through a multi-tiered cropping system or supporting inputs.

Productivity, Equity and Sustainability

Productivity : The productivity of both the

Fig 2



Relative availability of Forest Products in regenerating *Shorea robusta* Forest (Projected Value Over Time)

natural forests as well as the plantations has to be optimised and for this necessary inputs have to be provisioned. The terms major forest produce and minor forest produce have lost their old connotation. While timber, poles, firewood continue to be termed major forest produce, the others are termed Non-timber Forest Products or Non-wood Forest Products. Non-timber Forest Products in sal forests if systematically exploited and marketed can bring in a sustained income for the community, which in many instances would exceed that from the so-called major forest produce.

In a plantation production system, introduction of multi-tiered cropping with appropriate inputs may help. This in effect will be a high-input high-output model and will ensure an intermediate flow of goods or income.

Equity : The equity issues come up in two broad areas, intra FPC and inter FPCs. Within a F.P.C., economic levels vary among land owning households, landless households, scheduled castes and tribes, and women folk whose life style is inter-woven with collection of fuelwood and Non-timber Forest Products Such issues are best settled by the committee members themselves with minimal outside counselling or intervention.

Inter F.P.C. equity issues arise for the fact that due to situational advantage some committees happen to manage large areas e.g. 500 ha or so while others are attached to a mere 20 ha or so. Efforts should be made to re-group areas wherever possible to restore some parity. For committees burdened with more of bare/derelict areas, compensation may be in the form of higher employment through plantation and other resource building activities and a higher dose of supporting programmes in the fringes.

Sustainability : The most important point about sustainability is the community's perception of the benefits that flow from the forests. This alone would motivate them to manage the forests in sustainable way. The motivation at no point of time should entirely depend on the Government initiated employment generating work programme, as in that case the people may abandon the efforts or even destroy the forests if such work programmes do not materialise or as soon as they are stopped. Nevertheless, since recuperation of degraded forests almost invariably involves a long gestation period, some initial support with perceptible benefits is required. This is provided through a project and micro-planning, which will be discussed in the following paragraphs.

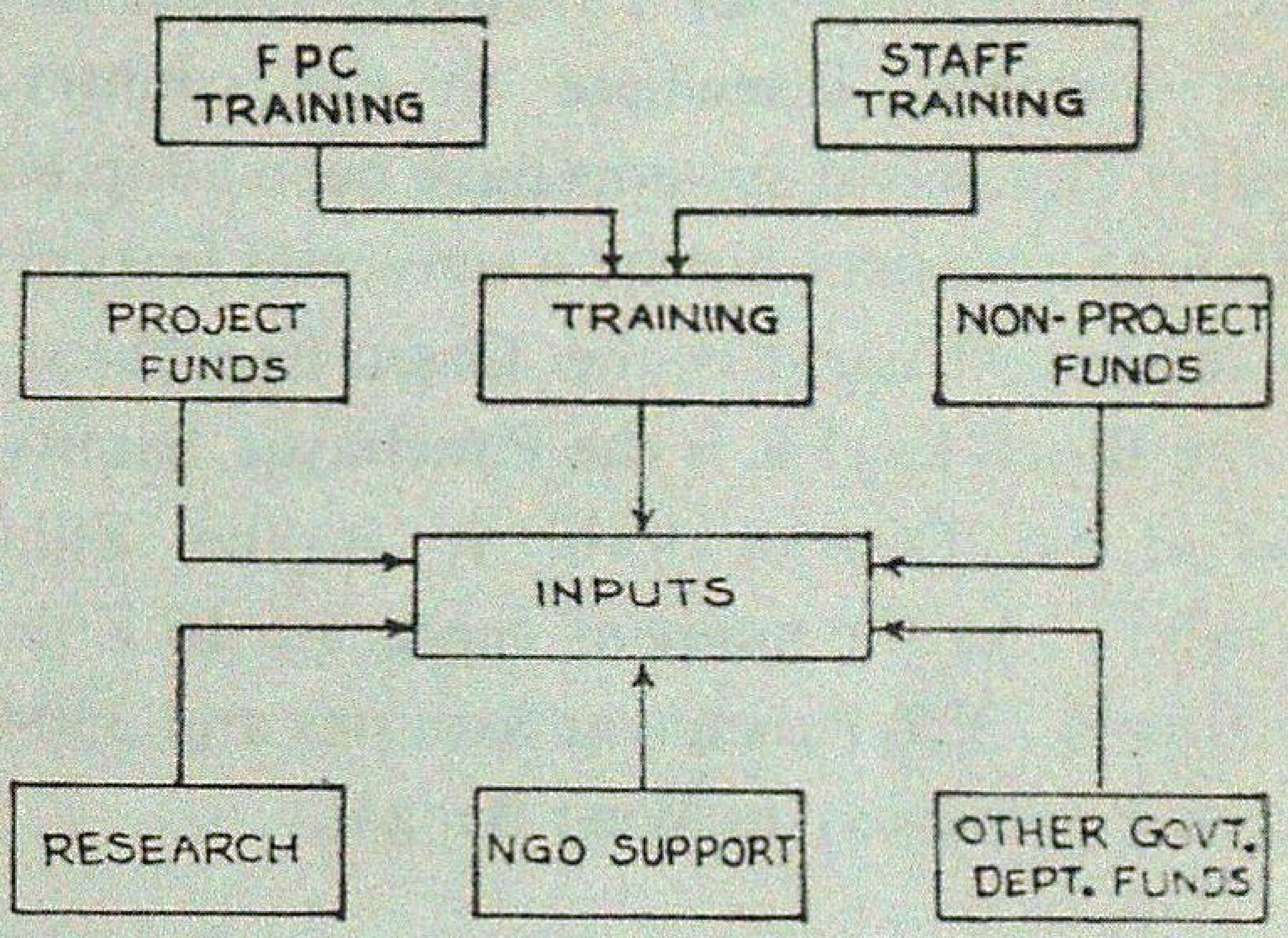
Micro-planning : Since we are dealing with communities through Forest Protection Committees, linkage of the resources of a small area with specific identified groups can be effectively established only through micro-plans. Since we will be dealing mostly with the people in the fringes and since the work components need not necessarily be entirely restricted to forestry activities, this can be termed an eco-development plan is a restrictive sense. Micro-plans depend on available resources, areas of investment, people's needs and aspirations and an agreed formula for sharing of the usufructs. They are drawn up with the FPC members who more or less decide on the priorities within the available options. For proper drawal of micro-plans computer-friendly formats have been developed and short orientation-cum-micro-planning courses are being run to train up staff. Micro-plans will serve as a memorandum of understanding between the Department and the villages and will ensure continuity of work.

Institutions supporting Joint Management System

Government : Government has to issue an order in the form of a resolution to serve as an enabling provision for constitution of the committees. The resolution should spell out the composition, duties and functions of such committees. It should also indicate in clear terms the usufructuary benefits to which the Forest Protection Committees will be entitled along with the penal provisions.

Forestry Personnel : Since basically it is the forest staff who will have to take up managerial functions they should be adequately groomed for the purpose. This will involve training for orientation, refresher courses for forestry as well as training in community development programmes which may be area specific and strictly not within the purview of forestry operations.

Fig. 3



Joint Management inputs

Forest Protection Committees : The composition etc. have already been discussed. They should preferably undergo a short orientation course apart from training in self employment schemes.

The Forest Protection Committees have to be apolitical to immunise them against perturbations on account of changes in the political scenario. Nevertheless it must be recognised as an institution and supported by power that be.

With this objective in view the committees have been tied up with the various tiers of the Panchayat system. In West Bengal there is a three tiered Panchayat system and the Panchayati Raj is quite firmly established. In the FPCs there are representatives of the Panchayat bodies. Through this, the Panchayat institution has

got involved in the joint forest management systems, giving stability to the FPCs and providing them with the necessary political and mass support.

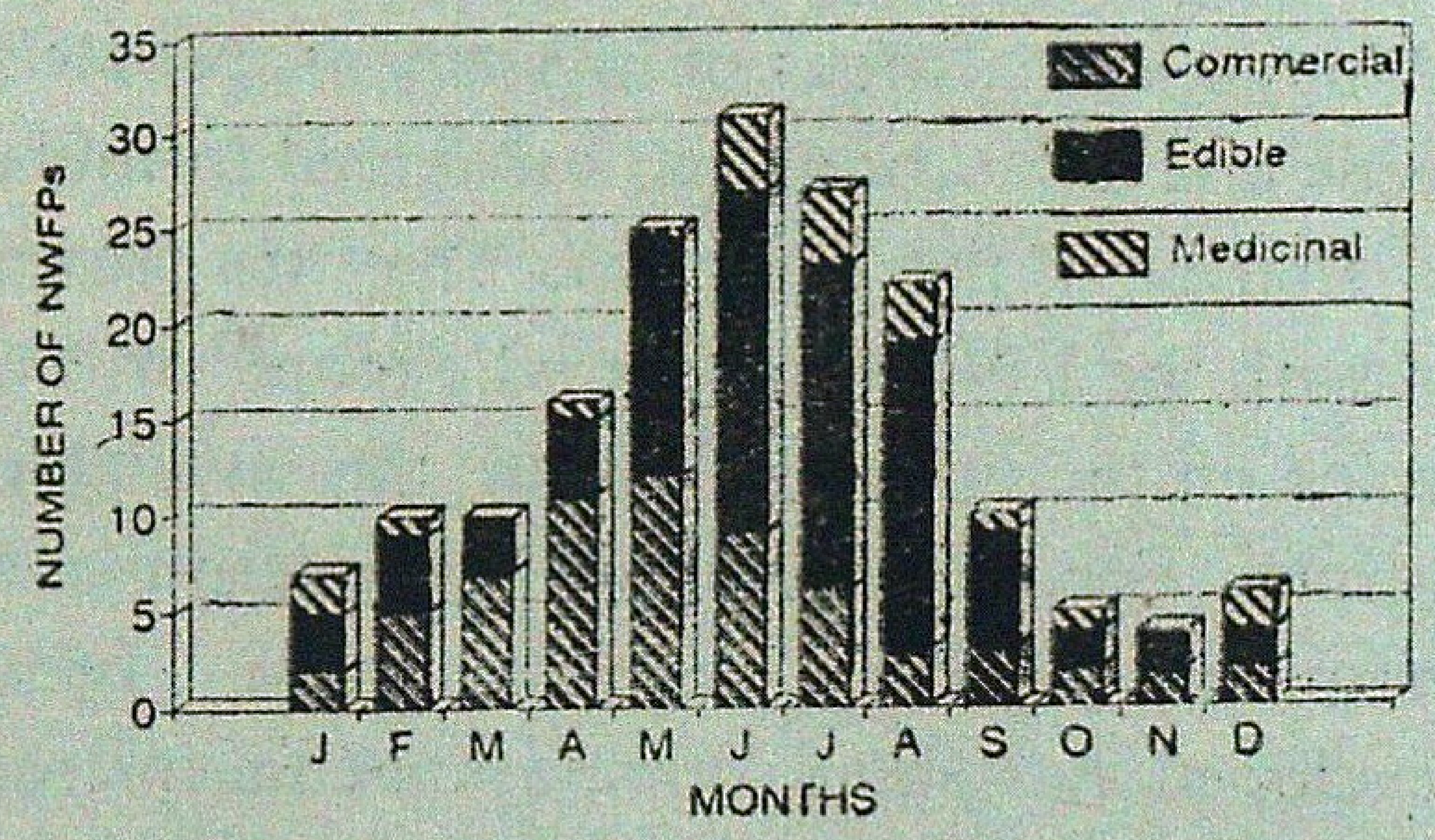
Panchayat Institutions : In West Bengal under the provision of the West Bengal Panchayat Act, 1973, a three-tier Panchayat system has been formed. Elsewhere in the country, similar Panchayat systems have been adopted although this may not be a universal feature. At the lowest tier it is the Gram Panchayat, at the Block level it is the Panchayat Samity and at the District level it is the Zilla Parishad. At the moment there are 16 Zilla Parishads, 339 Panchayat Samities and 3304 Gram Panchayats in West Bengal.

The Gram Panchayats are at the grass roots level comprising a few villages. Members of all these three bodies are elected through adult franchise, once every five years.

The three levels of Panchayat Raj more or less correspond to the the three levels of forests adminstration, i.e. Beat level, Range level and the District level. Therefore, it is easy to tie up one level of the Panchayat system with the corresponding level of the forest adminstration.

Since implementation of forestry schemes has a poverty alleviation gamut in rural areas, Government of West Bengal thought it fit to closely associate the Panchayat institutions with the implementation of the forestry works. Accordingly in the year 1985 the Government issued orders to the effect that the Divisional Forest Officer and the Range Officer or the Beat Officer will be members of the "Bon-O-Bhumi Sanskar Sthyee Samiti" of the Zilla Parishad and the Panchayat Samities respectively. The areas where the interactions should take place have also been clearly defined. This clearly brought out the necessity of associating the Panchayat representatives with the Forest Protection Committees and also the Panchayat Samities and the "Bon-O-Bhumi Sanskar Sthyee Samiti" at the District level.

Fig. 4



Seasonal NWFP Availability
Jamboni Range, Western Circle

The Panchayat bodies being elected bodies have the necessary political base. Therefore, through such arrangement necessary political support for the joint management system has been obtained. But Forest Protection Committees continue to be apolitical in character. Apart from providing a social and institutional look to the Forest Protection Committees, the Panchayats have been of substantial help in providing stability to the Forest Protection Committees, in resolution of disputes and in providing social acceptability.

Non-Government Organisations (N.G.Os.) : One reason why in the traditional forest management, Forest Departments were unable to tackle the degradation problems is the limited institutiona capacity. To sustain

the participatory management the limited institutional capacity is likely to prove inadequate. For supporting programmes N.G.Os. can help in a big way. Besides in many instances local N.G Os. by carrying out awareness compaigns can make the dialogue between a forester and the communities easier. The N G.Os. can also provide material support in organising various training programme in micro-planning and the investigative research in specific areas.

Other Government Departments : Work programmes taken up in the fringe areas by other Government Departments may provide some inputs for the micro-plans to be drawn up for a particular F.P.C. area.

A good forest manager or a Non-Government Organisation may facilitate such collaboration. This is further facilitated if it is possible to obtain a policy level decision from the Government enjoining such activities. Unrestricted grazing by scrub cattle is considered one of the major contributors towards the rapid degradation of both natural as well as artificially regenerated forests. A collaborative programme with the Animal Resource Development Deptt. for improving the indigenous breed by artificial insemination together with reduction of scrub cattle may necessitate Forest Department to provide fodder grasses raised as intercrops with forest species. Such programmes will not only effectively control wanton grazing in the forests, but also provide additional income to the Forest Protection Committee members. There may be many other areas where such joint actions are possible.

Research and Development : There is no denying the fact that present productivity of the forests is way below the potential. The research organisations in the States require immediate strengthening by placing officers with correct aptitude and background in appropriate positions in a policy framework. If necessary, services of Scientists may be obtained on contract basis for specific purposes. Linkages should be established with ICFRE and other Research Institutions. Research should be given a higher status with considerably higher budget allocation.

Community Development Programmes : To sustain the collaborative partnership in a joint management system it would be necessary to provide for supporting activities in :

- Training of FD and FPC leaders;
- Micro-planning and resource management;
- NTFP (including fodder) cultivation—management, processing and marketing;
- Agro-forestry alternatives and Farm forestry management.

Training for the purpose may organised by expanded activities of the Non-Government Organisations if necessary through grants and contracts and also other institutions.

In addition to the technical research discussed earlier, it would be necessary to promote multi-disciplinary research to ensure improved economic returns to the Forest Protection Committee members.

Reduction of current level of wood fuel used will be another area which could be critical to the success of the programme.

The multi-disciplinary research should cover :

- The ecology, management;
- Silvicultures, processing and marketing of NTFPs;
- The organisation, functioning, conflict resolution strategies;
- Methods of reducing fuelwood consumption;
- The ecological and economic assessments of various Agro-forestry alternatives.

Necessity of a Project

From what has been discussed earlier, it is clear that through joint management system two clear objectives have to be atteined; restoration of the degraded forests and an improved productivity with all attandant benefits. To sustain the joint management system over the year there has to be a firm assurance about a regular flow of funds, so that the commitments made by the Government through micro-plans are honoured. Failure to do so may lead to the break-down of the system and destruction of the forests especially during the initial years. Besides, the whole exercise is a complex of activities using resources to provide benefit. Therefore on both counts, this can best be implemented in the form of a project for at least a period of 5 years. When this project is tagged with the IDA assistance, it looks more secure. This is what is being done in West Bengal.

SUMMARY

The management systems developed and followed over a hundred years were rendered ineffective in the post independence era due to various factors. The denudation of forests could not be prevented. Participatory management of forests is slowly emerging the only viable alternative in the national scenario.

In this paper, an attempt has been made to focus on the different aspects of participatory management, e.g. policy changes, institutional arrangements, equity issues, input packages, micro-planning, research needs, etc.

It has further been suggested that at the initial stages to ensure continuity, it is better to implement the programme through a project.

वन प्रबन्ध में जनता का सहयोग

एस० पालित

सारांश

विगत सौ वर्षों से अधिक समय के दौरान विकसित एवं व्यवहृत प्रबन्ध प्रणालियां स्वातंत्रयोत्तर काल में अनेक कारणों से अप्रभावकारी बन गई हैं। उनसे वनों का विनग्नीकरण रोका नहीं जा सका। अब के राष्ट्रीय परिदृश्य में वनों का सहयोगी प्रबन्ध करना ही एकमात्र प्रभावकारी विकल्प के रूप में धीरे-धीरे उभर रहा है।

प्रस्तुत अभिपत्र में सहयोगी प्रबन्ध के भिन्न-भिन्न पक्षों अर्थात् नीतियों में परिवर्तन, सांस्थानिक व्यवस्थाए, न्याय के प्रश्न, निवेश के उपायपुंज, सूक्ष्म आयोजना, अनुसधान की आवश्यकताए इत्यादि पर प्रकाश डालने का प्रयत्न किया गया है।

इसके अतिरिक्त, यह भी सुझाया गया है कि प्रारम्भिक अवस्था में, निरन्तरता निश्चित बनाए रखने के लिए, अच्छा यह होगा कि इस कार्यक्रम को परियोजना का रूप देकर क्रियान्वित किया जाए।

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CORRELATION BETWEEN DIAMETER AND RESIN YIELD BY RILL METHOD OF TAPPING

D.C. CHAUDHARI, C.L. GOEL, B.D. JOSHI, D.N. UNIYAL, AMBA PRASAD AND R.S. BIST

Minor Forest Products Division, Forest Research Institute, Dehra Dun (India)

Introduction

Resin is the most important raw material for the rosin and turpentine industries which is obtained from different indigenous and extoic pines in India. *Pinus roxburghii* is the only species in India from which resin is tapped regularly by traditional Cup and Lip method or by Rill method to meet the requirement of the Indian industries, though it is in very short supply. Owing to the diversified use of oleo-resin products in various industries, the demand of the same is increasing in the country, while the production has come down considerably from 74,000 M Tons in 1975-76 to 35,000 M Tons in 1985-86. During 1986-87, India has imported 1269.2 Quintals of other Balsams oleo-resins worth Rs. 21,60,227 from different countries.

The resin yield depends on several factors, viz, temperature, humidity, evapo-transpiration, viscosity, periodicity, tree characters, age, individual variation, diameter, crown size, crown density, crown height, twist, tapping method, stimulant used and width of blaze, etc (Deshmukh and Payal, 1964; Deshmukh and Uma Dutt, 1967; Joshi, 1972; Kedarnath, 1971; Lohani, 1968, 1970; Mathauda, 1956, 1961; Rajkhowa and Waheed Khan, 1962; Seth and Rajkhowa, 1961; Verma and Pant, 1978).

Lohani (1985) reported a marked correlation of resin yield with diameter from chir pine trees varying from 30 cm to 60 cm diameter tapped by Cup and Lip method. He has reported 10% increase in yield with a rise in diameter of 5 cm. The region of maximum yield being 37.5-47.5 cm.

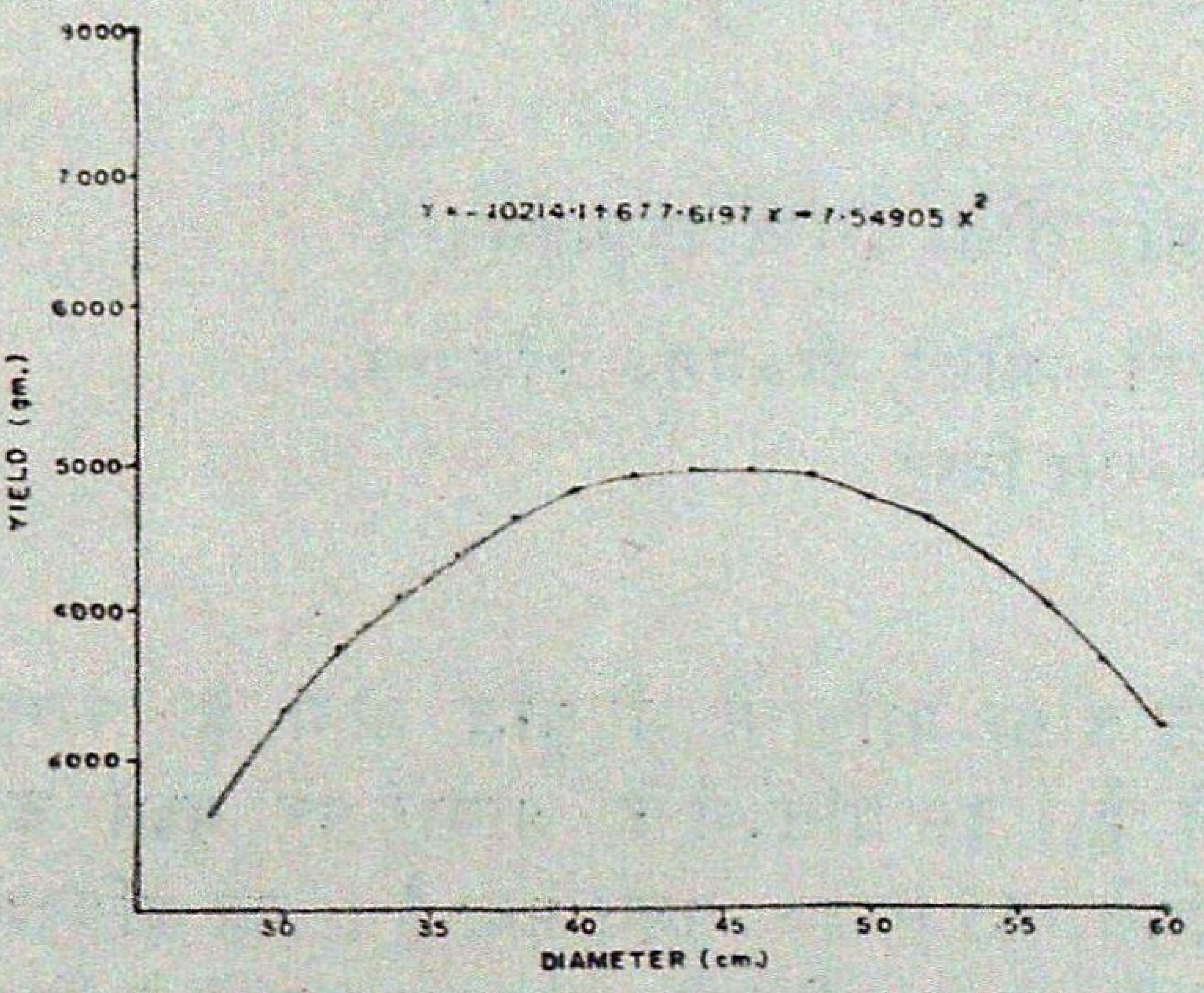
The literature survey revealed that no work has been done on the relation between diameter and resin yield when tapped by Rill method. Therefore, detailed studies on the correlation of resin yield with diameter has been carried out and the results obtained are discussed in this paper.

Material and Method

Thirty *Pinus roxburghii* trees of Chakrata provenance of varying in diameter from 33 cm to 50 cm were selected for tapping resin by Rill method in the Champion Block of New Forest which were planted in 1930. The experiment was initiated in 1986 and concluded in 1989. Freshening was carried out during tapping season, i e., from March to October. Weekly freshening with the help of freshening knife was carried out followed by the treatment of 20% mixture of sulphuric and nitric acids (Volume/Volume) on channel faces (rills). The average width of the bark left between consecutive rills was 5 mm and the average width of the rills was

5 to 6 mm. The blaze attained a height of 34 to 36 cm in one tapping season. The depth of the rills was about 2 mm in the wood which was the sufficient depth to open the closed resin ducts. The total number of rills were 32 in eight months. Weekly resin yield from each tree was recorded correct to a gram in the various diameter classes. The average annual yield vis-a-vis diameter are presented in Fig. 1.

Fig. 1



Correlation between diameter and resin yield

Discussions

A second degree polynomial regression function was fitted to observed data for average yield over 4 years using the diameter as independent variable (x). The equation derived is as under :

$$Y = -10214.1 + 677.6187\,x - 7.54905x^2$$

Based on the above model, optimum diameter of tree where yield will be maximum is observed to be 45.0 cm. Thus, it is concluded that the tree having diameter around 45 cm will be giving highest resin yield in this area.

The yield increases as the diameter increases upto 45 cm and then it reduces. The model will be applicable for forecasting yield from the trees having diameter between 35 to 55 cm (Fig. 1).

Average value of resin yield in each diameter class and year have been worked out, as presented in Table 1.

Table 1

Showing average yield per blaze in each of the diameter classes tapped.

Diameter class (cm)	1986	1987	1988	1989	Average
	Yield (kg)	Yield (kg)	Yield (kg)	Yield (kg)	Yield (kg)
33 - 35	3.924	4.346	4.027	4.717	4.252
35 - 40	4.334	5.272	3.958	4.705	4.567
40 - 45	4.772	5.713	5.033	5.935	5.363
45 - 50	4.276	4.894	4.829	5.393	4.848
50 and above	2.838	4.587	3.631	4.420	3.869

From this table, we may draw the following inferences :

1. Mean yield increases upto 45 cm diameter and then decreases.
2. Mean yield of resin found to be maximum in the year 1987 and 1989, as compared to the corresponding previous year 1986 and 1988 respectively.
3. The highest yield was observed in 1989 for diameter class 40-45 cm and the minimum yield was observed to be 2.838 in the year 1986 over 50 cm diameter.

SUMMARY

Resin yield increases as the diameter increases upto 45 cm and then it decreases. Based on the model, optimum diameter of trees where yield will be maximum is observed to be 45 cm. Th's model will be used for forecasting the resin yield from the trees having diameter between 35-55 cm.

लीसा टिपान की रेला विधि में व्यास और लीसा प्राप्ति का सहसंबन्ध

डी०सी० चौधरी, सी०एल० गोयल, बी०डी० जोशी, डी०एन० उनियाल,
अम्बा प्रसाद व आर०एस बिष्ट

सारांश

वृक्ष व्यास के 45 सेमी० तक बढ़ते जाने पर उससे लीसा प्राप्ति में भी वृद्धि होती है, परन्तु इसके बाद उसके बढ़ने पर लीसा प्राप्ति घटने लगती है। इस प्रतिदर्श के आधार पर वृक्षों का इष्टतम व्यास, जिस पर लीसा प्राप्ति भी अधिकतम मिले, 45 सेमी० पाया गया है। यह प्रतिदर्श 35–55 सेमी० तक व्यास वाले वृक्षों से मिल सकने वाली लीसा प्राप्ति के पूर्वानुमान लगाने के लिए उपयोग में लाया जाएगा।

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VEGETATION SURVEY AND ECOLOGICAL STUDIES UNDER SILVER FIR AND SPRUCE FORESTS OF HIMACHAL PRADESH

R.P. SINGH AND M.K. GUPTA*

Conifers Research Centre, Shimla (Himachal Pradesh)

Introduction

In forest ecosystem after felling, the microclimate and other physical characteristics are altered which initiate a natural process of reclamation and restoration of ecological balance of these areas. Large scale felling of forests is causing destruction of temperate forest ecosystem and is resulting in soil erosion, floods, land slides, drying up of water sources and ultimately upsetting not only the economy of the local people but also the people living far away in the plains. The greenary in such felled forests is restored. The present paper deals with the detailed vegetation survey and ecological studies of ground vegetation in silver fir and spruce (*Abies pindrow* and *Picea smithiana*) forests after fellings had been carried out in these areas.

Description of study site

This study was undertaken in compartment Hawan C 1 (c), having an area of 40 ha near Narkanda, Kotgarh Forest Division, Himachal Pradesh (77° 27′ 30″E longitude and 31° 15′ 30″ N latitude). The area is at elevation of 2650 m above m.s l. and receives high rainfall during the monsoon and heavy snowfall during winter. Soil is silty clay loam and clay loam.

Fellings were carried out in the study site during 1970-71 onwards and the area was closed during 1984-85, when silver fir and spruce was planted.

This study was conducted for three years from 1984 to 1986 under spruce-fir (*Picea smithiana* and *Abies pindrow*) forests, in which fellings were started in 1970-71 onwards. This compartment has 7-15% slope and northern-north-eastern aspects.

Materials and Methods

This compartment was divided into forty gradients (20 m wide) from top to bottom along the slope and at random quadrates (1×1 m size) were laid out in each gradient along the slope. In each quadrate, the number of species occurred, their diameter and height were recorded. Frequency, abundance, density, relative dominance, relative density and relative frequency have been worked out for each species to find out their Importance Value Index (I.V.I.) in the community by the method described by Mishra (1968).

Results and Discussion

The results of vegetational analysis under spruce-fir forests at Narkanda are presented in Table 1. It is evident from the results that maximum diameter was attained by *Cnicus argyracanthus* (1.48 cm) followed by *Impatiens thomsoni* (1.11 cm), *Rumex nepalensis* (0.76 cm), *Curculigo orchioides*

* Presently at Ecology & Conservation Division, Forest Research Institute, Dehra Dun (U.P.)

(0.73 cm) *Salvia glutinosa* (0 61 cm). *Swertia cordata* (0 57 cm) and so on in that order (Table 1) The maximum average height was obtained by *Impatiens thomsoni* (132.60 cm) followed by *Cnicus argyracanthus* (106.60 cm), *Corydalis cornuta* (104.16 cm), *Lactuca brunoniana* (98 0 cm), *Polygonum amplexicaule* (78.42 cm), *Anemone rivularis* (77.74 cm), *Salvia glutinosa* (73.20 cm), *Swertia chirata* (71.74 cm) and *Anaphalis cinnamomea* (66.06 cm) in decreasing order. Maximum basal area was recorded for *Cnicus argyracanthus* (1 729 cm^2) followed by *Impatiens thomsoni* (0.971 cm^2), *Rumex nepalensis* (0.453 cm^2), *Salvia glutinosa* (0 294 cm^2), *Swertia cordata* (0.255 cm^2) and so on in decreasing order. Maximum frequency was recorded for *Fragaria indica* and *Anemone rivularis* (87.87%) and minimum for *Swertia chirata; Erigeron alpinus; Lactuca brunoniana; Curculigo orchioides; Anaphalis cinnamomea; Nepeta leucophylla; Strobilanthes glutinosus; Cnicus argyracanthus* and *Circaea cordata* (3.03%). However, the above mentioned species have the same chance of record in the ecosystem and their distribution in the system was recorded equally. The density varies in between 0.03 to 31.75, being maximum for *Fragaria indica* and minimum for *Swertia chirata*; *Erigeron alpinus*; *Lactuca brunoniana* and *Curculigo orchioides*. However, *Swertia chirata*; *Lactuca brunoniana*; *Erigeron alpinus* and *Curculigo orchioides* have the same number of individuals in the present study (Table 1). The frequency, density and cover are all important parameters for the study of a community in their own right but however, they are of little importance and prove to be inadequate when used to provide data on importance of a particular species in the community. To denote the ecological success of a species, Curtis (1959), developed Importance Value Index which is a sum of relative frequency, relative density and relative dominance. It is evident from the results of this study that this community is dominated by *Fragaria indica* by having maximum I.V.I (91.88) and *Swertia chirata* has the minimum value of I.V.I. (0.54) which indicates that the contribution of *Swertia chirata* is minimum in formation of this community. The co-dominant species of this community, which are determined on the basis of Importance Value Index (I.V.I.), are *Impatiens thomsoni*; *Anemone rivularis*; *Rumex nepalensis*; *Galium parene*; *Pteris multifida*; *Calamintha clinopodium*; *Arenaria serpyllifolia*; *Trifolium pratense*; *Salvia glutinosa*; *Athyrium* sp.; *Polygonum alatum*; *Circaea cordata*; *Myriactis nepalensis*; *Adiantum candatum*; *Pimpinella acuminata*; *Polygonum amplexicaule*; *Viola zerpens*; *Cnicus argyracanthus*; *Viola biflora*; *Swertia cordata*; *Corydalis cornuta*; *Cnicus wallichii*; *Strobilanthes glutinosus*; *Nepeta leucophylla*; *Anaphalis cinnamomea*; *Curculigo orchioides*; *Lactuca brunoniana* and *Erigeron alpinus* in that order. Singh *et al.* (1983) have studied the distribution of weeds in spruce and silver fir forests managed under selection, shelterwood and clear cutting systems and recorded *Fragaria indica* an abundant species in all the systems. In the present study also, *F. indica* is dominating the community by having maximum values of frequency and Importance Value Index (I.V.I.).

Ground vegetation has the potential for enhancing the productivity of the site and it needs the scientific studies in various field of silviculture (seed germination, nursery and

Table 1

Phytosociological studies under Abies pindrow and Picea smithiana forests at Narkanda

Name of species	Averags dia. (cm)	Average height (cm)	Basal area/ plant (cm^2)	Frequency (%)	Abundance	Density	Relative dominace	Relative density	Relative frequency	Importance Value Index (I.V.I)
1	2	3	4	5	6	7	8	9	10	11
Fragaria indica	0.34	14.12	0.095	87.87	36.13	31.75	35.98	41.55	14.35	91.88
Impatiens thomsoni	1.11	132.60	0.971	15.15	16.80	2.54	29.45	3.33	2.47	35.25
Anemone rivularis	0.29	77.74	0.066	87.87	11.20	9.89	7.74	12.88	14.35	34.97
Rumex nepalensis	0.76	65.00	0.453	57.57	5.31	3.06	16.54	4.00	9.40	29.94
Galium aprene	0.11	34.40	0.009	45.45	13.93	6 33	0 74	8.28	7.42	16.44
Pteris multifida	0.20	55.08	0.032	39.39	10.30	4.06	1.54	5.31	6.43	13.28
Calamintha clinopodium	0.15	31.60	0.018	39.39	8.00	3.15	0.69	4.12	6.43	11.24
Arenaria serpyllifolia	0.10	24.36	0.009	24.24	16.25	3.93	0.43	5.15	3.96	9.54
Trifolium pratense	0.08	13.22	0.005	33 33	7.09	2.36	0.15	3.09	5.44	8.68
Salvia glutinosa	0.61	73.20	0.294	24.24	2 62	0.63	2 22	0.83	3.96	7.01
Athyrium sp.	0.11	35.42	0.010	27.27	5.11	1.39	0.17	1.82	4.45	6.44
Pteridium equilinum	0.14	54.95	0.015	18.18	9.33	1.69	0.32	2.22	2.97	5.51
Polygonum alatum	0.13	19.98	0.014	18.18	5 66	1.03	0.17	1.34	2.91	4.48
Circaea cordata	0.47	45.04	0.170	3 03	34 00	1.03	2.08	1.34	0.49	3.92
Myriactis nepalensis	0.32	50.26	0.008	18.18	2.16	0.39	0.37	0.51	2.97	3.86

Contd ..

1	2	3	4	5	6	7	8	9	10	11
Adiantum candatum	0.15	18.32	0.017	9 09	11.00	1.00	0.21	1.30	1.48	2 99
Pimpinella acuminata	0.15	48.28	0.018	12.12	3.50	0.42	0 09	0.55	1.98	2.62
Polygonum amplexicaule	0.25	78.42	0.049	9 09	6.33	0.57	0 34	0.75	1.48	2.57
Viola serpens	0.09	11.87	0.007	6 06	18.50	1.12	0.09	1.46	0.99	2.54
Cnicus argyracanthus	1.48	106.60	1.729	3.03	3 00	0 09	1.87	0.12	0.49	2.48
Viola biflora	0.32	23.90	0.084	9.09	4 00	0 36	0.36	0.47	1.48	2.31
Swertia cordata	0.57	53.73	0 255	6 06	3 00	0.18	0 55	0.23	0.99	1.77
Corydalis cornuta	0.28	104.16	0.062	6.06	2.50	0 15	0.11	0.19	1.00	1.30
Cnicus wallichii	0.06	12.14	0.003	6.06	2 00	0.12	0 04	0.15	0.99	1.18
Strobilanthes glutinosus	0.24	25.36	0 040	3.03	5 00	0.15	0.07	0.19	0.49	0.75
Nepeta leucophylla	0.16	30.08	0.021	3.03	5.00	0.15	0.04	0 20	0 49	0.73
Anaphalis cinnamomea	0.23	66.06	0.043	3.03	4 00	0 12	0.06	0.16	0.49	0.71
Curculigo orchioides	0.73	31.46	0.421	3.03	1.00	0.03	0.15	0.04	0.49	0.68
Lactuca brunoniana	0.45	98.00	0.159	3.03	1.00	0.03	0.05	0.04	0.49	0.58
Erigeron alpinus	0.44	40.23	0.152	3.03	1.00	0.03	0.05	0.04	0.49	0.58
Swertia chirata	0.23	71.74	0.042	3.03	1.00	0.03	0.01	0.04	0.49	0.54

planting technique etc.), ecological studies on nutrient cycling through litter decomposition and biomass determination of individual species etc. (Bahuguna, 1990).

Viburnum foetens Done., a large deciduous shrub (family-Caprifoliaceae) needs a cool moist place for its good growth and occurs commonly in open areas of spruce-fir (*Abies pindrow* and *Picea smithiana*) forests at high altitude. However, this plant did not come in any quadrate laid down for this study. Singh *et al.* (1986) have determined the biomass of different plant parts, morphological characters, silviculture, root characteristics and soil binding factor of *V. foetens* in this area.

Acknowledgement

The authors are thankful to the Scientest Incharge, Forest Botany Discipline, Forest Research Institute, Dehra Dun for identifying the plants and to Shri Prakash Chand, T.A.I., Conifers Research Centre, Shimla, for his assistance in the field work.

SUMMARY

This paper describes the phytosociological studies under spruce-fir (*Picea smithiana* and *Abies pindrow*) forests at Narkanda, Himachal Pradesh. Abundance, frequency, density, Importance Value Index (I.V.I.) and morphological characters such as diameter, height and basal area have been worked out for individual ground vegetation species. The community is dominated by *Fragaria indica* and the contribution of *Swertia chirata* is recorded least in community development.

हिमाचल प्रदेश के रजत तालीशपत्र और प्रसरल वनों की वनस्पतियों का सर्वेक्षण और पारिस्थिकीय अध्ययन

आर०पी० सिंह व एम०के० गुप्त

सारांश

इस अभिपत्र में हिमाचल प्रदेश के मारकडा स्थल के प्रसरल–तालीशपत्र (पीसिया स्मिथियाना व एबीज पिंड्रो) वनों के पादप-सामाजिकी अध्ययनों का वर्णन दिया गया है। प्रचुरता, बारम्बारता, घनत्व, महत्व मूल्य निर्देशांक और रचनाकारिकीय लक्षण जैसे व्यास, ऊंचाई और आधारिक क्षेत्र को भूमि की वनस्पति जातियों के लिए अलग-अलग निकाला गया है। इस समुदाय में फ्रैगेरिया इण्डिका का बाहुल्य है तथा समुदाय विकास में सबसे कम योगदान स्वेर्टिया चिराटा का होता आलेखित किया गया है।

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LANTANA WEED (*LANTANA CAMARA* VAR. *ACULEATA* LINN) AND ITS POSSIBLE MANAGEMENT THROUGH NATURAL INSECT PESTS IN INDIA

M.L. THAKUR, MUKHTAR AHMAD AND R.K. THAKUR

Forest Research Institute, Dehra Dun (India)

Introduction

Lantana camara L., a native of tropical and sub-tropical America, is an obnoxious weed, which has gradually invaded and naturalised in some of the most valuable biomes of the world, ousting at places, rich natural vegetation. Introduction to other parts of the world has taken place through human agency way back in nineteenth century. It has become a pest every where in its adopted homes. In fact, lantana is now considered as one of the ten worst weeds in the world and a symptomless carrier of sandal spike disease in India (Nayar and Shrimati, 1968).

Mechanical removal, burning and its suppression with weedicides have not proved fully successful, because of the large areas involved, its capability to resurge, and high operational and chemical cost, etc. Thesefore introduction of its enemies, the "*Natural Exotic Insect Species*" (NES) has been considered as the most promising line of approach in the management of the weed, as none of the indigenous lantana insects, recorded so far, has proved so effective so as to contain the further spread of the lantana weed (*vide infra*). Although lantana has been targeted to several introduced biological control agents since the beginning of this century, more concerted efforts have however, been made during the last few decades by several countries, including India. About 13 species of insects have been introduced into Hawaii, and a lesser number in other countries. In India, nine species of exotic natural enemies of lantana have so far been introduced and tried after the introduction of lantana seed-fly *Ophiomyia lantanae* in 1913, with little significant success. Of late, more requests are being received by the Expert Committee for import of bio-control agents of the weed, for permission of new introductions. Despite the general impression that the imported insects have done wonders in containing lantana in some countries, the fact remains that the problem still exists in challenging form. It is, therefore, time to have a fresh look of the whole problem of lantana menace and derive some meaningful conclusions from these introductions. In this article, an attempt has been made to review the biological control activites conducted so far on this weed in India and evaluate their effectiveness and current status and the possible options for future strategies.

Lantana Weed Problem

Lantana was introduced in India in 1809 (Calcutta Botanical Garden), as an ornamental plant due to its beautiful aromatic flowers. Prolific seed production and easy dispersal helped it in escaping

cultivation and becoming a pest, with serious dimensions.

Lantana is a perennial woody shrub with scrambling habit of growth. It flowers almost throughout the year, but rather uncommonly in wintry months in Northern-India. It is highly light demanding species and thrives well on well drained soil, with sufficient moisture and with climate, comparatively without extremes of heat and cold (areas with 1250-3750 mm rainfall). Excessive shade, such as dense forests, inhibits its growth. It cannot easily withstand excessive frost or hot winds. The attractive flowers are pollinated through the agency of insects and dispersal occurs through birds which feed on fruit and pass out the seeds in droppings. The lantana mainly invades forest areas, open wastelands, grazing grounds (pastures), road sides, canals, railway tracks, etc. in most parts of the country, displacing the local vegetation. Open forests and blanks are particularly vulnerable. Apart from impeding natural regeneration, this weed is posing serious problems in plantation forestry (Singh, 1976). It is also becoming naturalised in the submontane region of outer Himalaya, invading and spreading vigorously, rendering in the process large areas of valuable sal forests and pasture land useless, (Joshi, 1969). The lantana chokes all other vegetation and becomes the dominant species. The problem persists in challenging form in most parts of the country, particularly in peninsular India and N.E. India.

Historical review of introductions of lantana insects in India

The story of search for and discovery of suitable species of biocontrol agents makes a fascinating study and has been dwelt upon and reviewed (appearing at regular intervals) by many workers (Parkins and Swezey, 1924; Beeson and Chatterjee, 1940 and Roonwal, 1952). In the beginning of this century, the Government of India realised the seriousness of the lantana problem and appointed Y. Ramachandra Rao, an eminent entomologist of the time, to conduct an enquiry into the efficiency of the indigenous insect fauna of lantana before attempting introduction of natural exotic insect species. Rao (1920) carried out extensive surveys for nearly three years (1916-1919), throughout India and Burma and recorded 148* species of insects frequenting various parts (leaves shoot, flowers, fruit, seed etc.) of lantana and found that only a few of them were regular breeders on lantana. Of these, the plume moth *Lantanophaga* (*Platyptilia*) *pusillidactyla* (Walker), already known to have been in India for many years, was considered effective to some extent. and recommended its encouragement and further import. The seed-fly *Ophiomyia lantana* (Frog.) was imported in 1921, in spite of the strong reservations of the Imperial Entomologist, T.B. Fletcher and released at Bangalore. Although well established all over India within a span of few years, it failed to control lantana. In 1941, the lantana lace-bug, *Teleonemia scrupulosa* Stal. was imported by the Forest Research Institute, Dehra Dun from Australia. After three years of experimentation under quarantine conditions, the whole lot was destroyed as it was found to breed on some other plants of economic importance, particulary verbenaceous trees, including teak. Some of the

* Beeson & Chatterjee (1940) recorded over 400 insect species visiting lantana.

insects some how escaped from this lot. The bug is now well established all over India after it has been introduced in many new localities in the country. To augment the ongoing efforts to control lantana menace, Forest Research Institute has been importing regularly exotic insects mainly from Australia through the kind courtesy of Dr. K.L S. Harley of CSIRO, Queensland during the last few decades. After the introduction of *T. scrupulosa* in 1941 the next introduction was attempted in 1971 when two species of chrysomelid beetles, *Octotoma scabripennis* (Guerin) and *Uroplata girardi* Pic. were imported from Australia, followed by *Plagiohammus spinipennis* Thoms. in 1971, *Leptobyrsa decora* Drake (Dec., 1977). The chrysomelid beetles were declared safe and released in various parts of the country. The Cerambycid borer, *Plagiohammus spinipennis* experiments failed, while *Leptobyrsa decora* was declared unsafe and the lot destroyed.

Ecology of lantana insects in India

The lantana insects in India, as dealt with here, can be classified into two categories (i) *Natural Exotic Species* (NES), which dave either been introduced into India by the human agency or have got introduced through other dispersal agencies, particularly air-currents, and (ii) *Natural Indigenous Species* (NIS), which were screened by earlier workers, and found useful bio-control agents. Though no indigenous species, of its own, has been found to possess the ability to build-up population to a level which could check the spread of the weed, but some of them can form very useful component of the whole complex of biocontrol agents in certain pockets in the country and can therefore, be exploited for introduction to new localities.

(a) Introduced species

(i) The plume moth, *Lantanophaga* (*Platyptilia*) *pusillidactyla* (Walker) (Lepidoptera : Pterophoridae) : The dark brownish plume, a native of central and tropical South America, has been introduced and spread to various parts of the world, such as Burma, Hongkong, West Indies, Hawaii, etc. and is now a well established faunal component of both continental and Island communities. Its introduction into India also seems to be accidental and perhaps has taken place by upper air currents (Beeson and Chatterjee, 1940). It is a common species in South India. Recently Muniappan and Viraktamath (1986) have reported its occurrence on lantana flowers and berries in many localities in South India, especially in and around Bangalore. Rao (1920), after extensive surveys, concluded that the plume moth was perhaps the most efficient lantana insect, that had helped to keep lantana in check, but its efficiency was not really of high order. Interestingly it has proved a promising biocontrol agent in Hawaii from Mexico (Julien, 1982).

The moth lays eggs on the flowering buds or clusters of opened flowers of lantana. The larvae bore into the rachis or base of the corolla tube and feed on all parts of the flowers or young fruits, therely affecting seriously the production of berries. The species is polyphagous and apart from lantana, it also attacks the indigenous species of *Lantana*, *L. indica* and *Lippia germinata* (Beeson, 1941). Though considered to be a promising species in India, its population in the field is generally too low to be effective. Short life cycle, dependence on flowering plants and very high susceptibility

to natural enemies (predators and parasites), are some of the limiting factors, which have prevented it to become a useful agent in the natural control of lantana.

(ii) The lantana soft scale insect, *Orthezia insignis* Douglas (Homoptera : Orthezidae) : The precise country of origin of this lantana soft scale is obscure, however, it is very widely spread polyphagous species in the tropics, subtropics and warmer parts of temperate zones of many countries. This first record of its occurrence within the Oriental region seems to be from Sri Lanka where it was first observed in 1893 and within a span of 10-15 years its had spread all over the Island along with its host plant lantana (Beeson and Chatterjee, 1940). In India, it got introduced to Nilgiris (Tamil Nadu) probably from Sri Lanka (Fletcher, 1917) in the beginning of this century, prior to 1915, and later to Bangalore. In 1933, it was released in North-Salem Division (Tamil Nadu) for propagation on lantana. However it was later realised that though known to be a killer of the lantana, this species could do more harm than good, hence efforts were made to exterminate the bug, but without much success.

The species is polyphagous, and is known to attack a number of economically important plants, as well as weeds, such as *Eupatorium adenophorum* and *Chromolaena odorata* (Muniappan and Viraktamath, 1986) but it is particularly very common on lantana. Both nymphs and adults feed on the sap of the leaves and soft branches of the host plants. Feeding produces much honey-dew, so that direct injury to the host is aggravated by the development of associated sooty mould. As a result, the affected shoots are defoliated and become black, resulting in die-back. The species thrives better under shade and is capable of destroying dense lantana scrub. However, in view of its polyphagous nature, this species in probably not likely to prove a successful biocontrol agent of lantana, except under the most strictly supervised experimental conditions (Beeson and Chatterjee, 1940, Beeson, 1941).

(iii) The lantana seed fly, *Ophiomyia lantanae* (Frog.) (Diptera : Agromyzidae) : The lantana seed fly, a native of Mexico, was first introduced to Hawaii in 1902, from where it was introduced to New Caledonia (1908) and Fiji (1911), Queensland (1917) and Hongkong (1933). In India, it was introduced by the Department of Agriculture, Mysore Govt., first in 1913 and later successfully in 1921 when 273 flies were released in Bangalore. These introductions and subsequent attempts in 1927 and 1932 failed to provide any evidence of its impact on lantana berries. It was therefore, concluded that the introductions has failed. However, subsequent attempt (during 1932-34), provided some hard evidence of the occurrence of the seed fly in many localities all over India and Burma. In view of its wide spread distribution Subramaniam (1934) opined that occurrence of the seed fly on such a vast scale could not be the result of Bangalore liberation of 1921 from a small initial colony and concluded that the fly had been present all along in India, perhaps ever since the introduction of lantana. However, Rao's (1920) surveys of the lantana fauna, had clearly indicated its absence from India in 1919. According to him, high biotic potential of the seed fly and the influence of upper air currents were responsible for its rapid dispersal.

Table 1

Natural Exotic Insects Species (NES) introduced and tried for biological control af Lantana camara Linn.

Order/Family	Name of species	Localities of species	Period of releases	No. of rele-ases	Total No. of insects released	Remarks
1	2	3	4	5	6	7
1. Order : Coleoptera						
(i) Fam : Cerambycidae	*Plagiohammus spinipennis* (Thoms)	—	—	—	—	The imported pupae failed to yield beetles
(ii) Fam : Chrysomelidae						
Sub-fam : Hispinae	*Uroplata girardi* Pic.	In and around Dehra Dun (U.P)	June, 72 to July, 76	31	5655	Introduced into India along with its sister species, *O. scabripennis* from Australia. These species were found safe and released in the field at several places in the country, however, there appears to be no evidence of their establishment and dispersal to new areas.
		Haldwani,	9.8.76	1	1000	
		Nainital (U.P.)	22.8.77	1	250	
		Jammu (J&K)	7.12.79	1	100	
		Agricultural University (Solan), H.P.	12.9.76	1	5000	
		Jabalpur (M.P.)	9.10.77	1	300	
		Bhopal (M.P.)	17.10.75	1	1000	
		Siliguri (W.B.)	21.9.76	1	250	
		Trichur (Kerala)	8.2.79	1	100	
	Octotome scabripennis Guer	In and around Dehra Dun.	Sept, 72 to July, 76	22	5911	
		Haldwani (UP)	9.8.76	1	850	
		Nainital (UP)	22.8.77	1	500	
		Bhimtal, Nainital (UP)	26.7.73	1	520	

Contd ..

1	2	3	4	5	6	7
		Jammu (J&K)	7.12.79	1	100	
		Bhopal (MP)	17.10.75	1	500	
		Jabalpur (MP)	9.10.77	1	500	
		Trichur (Kerala)	8.2.79	1	100	
		Bangalore (Karnataka)	28.3.79	1	80	
2. Order : Diptera Fam : Agromyzidae	*Ophiomya lantanae* (Frog.) (Seed borer)	Bangalore (Karnataka)	No data available			It was believed that introduction of the fly had failed, however between 1932-34 it was found throughout India, from Travancore to Kangra (Beeson, 1941). Subramaniam (1934) believed that that fly had been present in India perhaps being accidentally introduced along with Lantana.
3. Order : Homoptera Fam : Orthezidae	*Orthezia insignis* Browne	Though widely distributed but no data are available on its ecological impact on the host plant.				Origin obscure. Probably introduced into India from Sri Lanka. Thrives better under shade rather than in the open. In view of its polyphagous nature, it has a very limited role as biocontrol agent.

Contd ..

1	2	3	4	5	6	7
Fam : Tingidae	*Leptobyrsa decora* Drake	—	—	—	—	Introduced into India by FRI. After host-specificity test under laboratory conditions, it was declared unsafe and the whole lot is supposed to have been destroyed.
	Teleonemia scrupulosa Stal.	In & around Dehra Dun.	12.9.76	1	3000	It is the first exotic insect imported by the Forest Entomologist from Australia in 1941 for biological control of Lantana. However, the cultures were destroyed on the erroneous belief that it might become a pest of teak. Subsequently it has been bred and released in many new localities in the country. Though well established it has failed to check the proliferation of the weed.
		Agricultural Univ., Solan (HP)	12.9.76	1	5000	
		Bhopal (MP)	17.10.75	1	2500	
		Chandrapur (Maharashtra)	23.10.76	1	9000	
		Shillong (Meghalaya)	14.2.76	1	6000	
		Pune (Maharashtra)	8.11.76	1	10000	
		Siliguri (W.B.)	21.9.76	1	5000	
		Trichur (Kerala)	8.[illegible].79	1	1000	

Contd...

1	2	3	4	5	6	7
4. Order : Lepidoptera						
Fam : Pterophoridae	*Lantanophaga* (=*Platyptilia*) *pusillidactyla* (Walker)	—	—	—	—	A native of tropical America, this species seems to have been introduced rather accidentally through upper air currents. Though considered promising, its population in the field is too low to be effective.
Fam : Torticidae	*Epinotia lantana* (Busk) (Seed borer)	Bangalore, Coorg (Karnataka) and Pandicherry	Fruit borar. Larve bore berries and affects seed production.			Neotropical species. Its int.oduction to India remains obscure. A potential biocontrol agent of Lantana and needs to be introduced to Northern India.
Fam : Noctuidae	*Hypena strigata* (Fabr.) *Diastema tigris* Guenne	Widely distributed from Africa-Australia	-do-			This species should be searched in Northern India exploited for biological control of the weed.
Fam : Pyralidae	*Salbia* (=*Syngamia*) *haemorrhoidalis* Guenne					Species with a high potential as biocontrol agents. Though initial attempts have failed, but it needs to be reinvestigated under Indian conditions.

Beeson and Chatterjee (1940) opined that the species was successfully introduced in 1921 and that subsequent dispersal throughout India was due to natural courses.

The small black seed fly lays one egg/fruit (in the green, brown and black fruits of the lantana), in which the kernel has hardened. The larvae feed within the outer pulp of the fruits. Sometimes, the larvae enters the seed and destroy the embryo. Initially, the infested lantana berry exhibit whitish or light coloured patches. Later the fruits dry-up and fall off. The short life cycle with as many as 21 generations in Northern India and still more in South India, had led to the belief that the fly had the ability to inhibit the seed germination and thus check the dissemination and regeneration of lantana. However, on the contrary, studies carried out in India have shown that not only the seed infested by the seed fly retain the capability to germinate, the germination percentage, which on the whole, is very low (less than 15% only), is almost at par in both attacked or unattacked seeds. Therefore, the seed fly can not be regarded as an important factor in the control/spread of the weed. It can however, play a role of minor economic value in preventing the dispersal of the seeds by birds by way of rendering the berries unattractive to them.

(iv) The lantana lace bug, *Teleonemia scrupulosa* Staol (Hemiptera : Tingidae) : The lantana lace bug, *Teleonemia scrupulosa* is the first insect to have ever been tried for biological control of lantana. It is therefore, little wonder that this insect is the most intensively worked and exploited natural enemy of lantana all over the world, following its success in drier areas of Hawaii. It has a long history of introduction to various countries. Koebele introduced this species to Hawaii in 1902 from Mexico, where it got well established by 1905 and was recorded severely damaging the weed. From Hawaii, it was introduced to Fiji in 1928 and then to Australia in 1934, where after initial failures, it got established throughout the lantana infested areas. In India, a colony of 80 adults was first imported from Canberra (Australia) in 1941 by the Forest Research Institute. However, the whole culture was supposed to have been destroyed in 1943, following erroneous belief (after extensive host specificity and biological studies) that the bug might become a pest of teak (Khan, 1945; Gardner, 1944). However spotting of a single individual a decade later in New Forest (Dehra Dun) confirmed that some insects from this culture, evidently had escaped accidently and got established in Doon Valley and its vicinity (Roonwal, 1952). He further concluded that the bug had travelled a distance of about 40 km from the point of escape (FRI, Dehra Dun), at an average speed of 4 km/year. Since then the bug has spread all over the submontane tract from Kangra to Kumaon as well as in the Indo-Gangetic plain (Joshi, 1969; Bisht and Bhatangar 1978).

Subsequently, detailed studies, conducted at Forest Research Institute (1971-73), showed that *T. scrupulosa* was not a pest of any consideration on teak or any other plant of economic importance in India other than lantana and that the species had migrated a distance of 300-500 km from Dehra Dun.

Following this. F.R.I. has been organising mass rearing and field release of this bug. More than 75,000 insects have so far been liberated during 1972-79 in lantana infested areas, covering several States, including Andhra Pradesh, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, West Bengal, Madhya Pradesh, Maharashtra, Meghalaya and Uttar Pradesh. These releases have led to the establishment and spread of the bug in many new localities in the country.

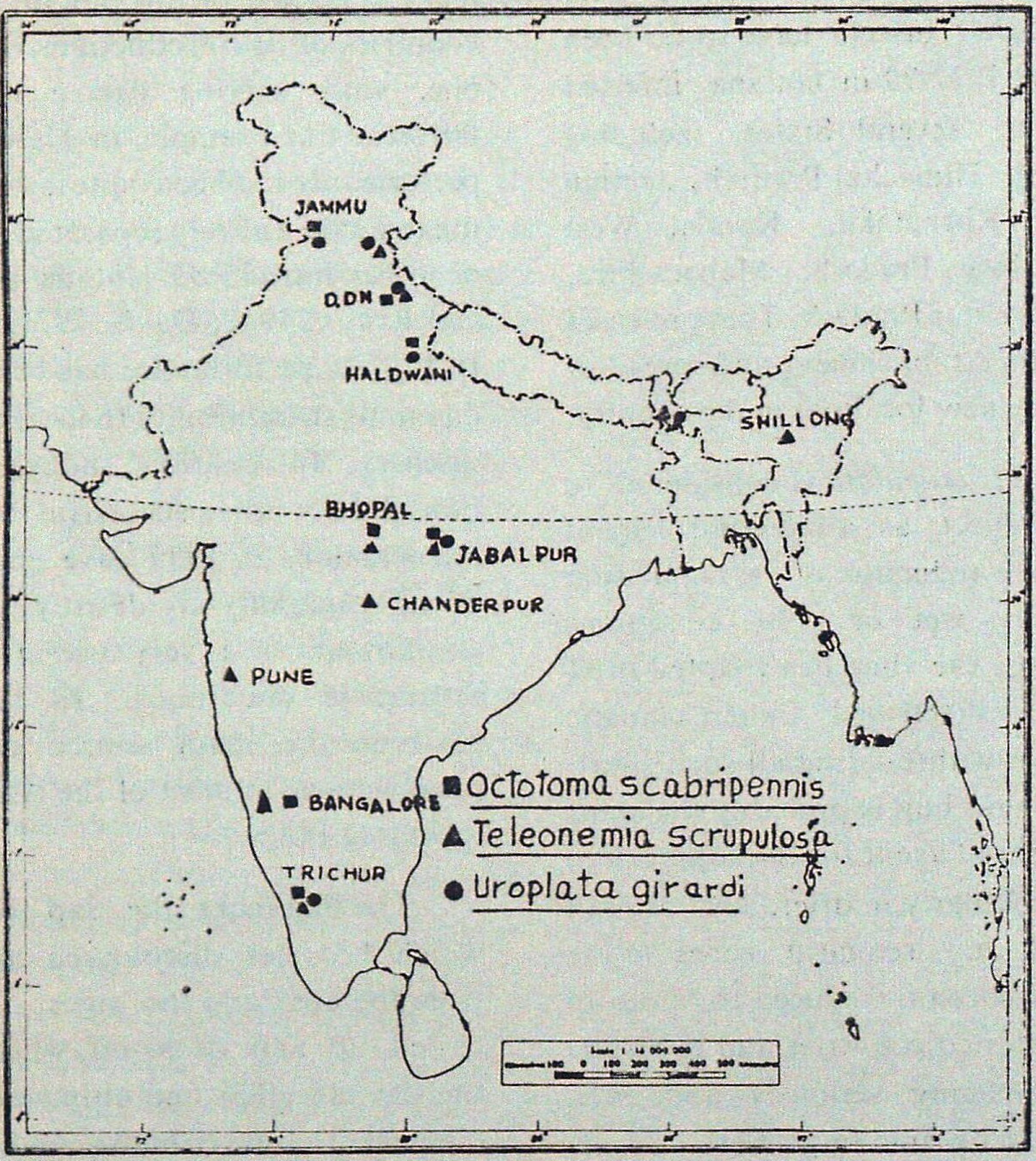
Although *T. scrupulosa* is considered to have limited effect as a bio-control agent because of severe reduction of its population under unusually wet or cold conditions (Harley, 1971), the bug has adapted itself well in highly diversified Indian climatic conditions. Notwithstanding all such shortcomings this tingid bug is probably the most useful and potential agent for the suppression of lantana, particularly in drier, low rainfall areas in arid and semiarid zones of the country. It has been introduced to most of the lantana infested countries and is performing well, damaging seriously and even killing the lantana plants in pockets.

The bug has been introduced into southern parts of India by the department of Central Plant Protection Training Institute, Hyderabad, from the culture received from the erstwhile Commonwealth Institute of Biological Control, Bangalore, during 1969 and 1970 as well as by the Forest Research Institute, Dehra Dun. This bug is now well established and widely spread in South India (Verma and Sadatullah, 1973). Severe infestations of lantana bushes by the lace bug have also been reported in Karnataka and Tamil Nadu (Sivaramakrishnan, 1976) and from Kerala (Joy, 1977). The performance response of this bug in most of the countries of its introductions has been mixed one, with varying degree of success and failures. For example, in Hawaii Islands, its performance has been quite impressive, though it can not be entirely separated from the effect of other introduced lantana insects (Davis and Krauss. 1962; Davis, 1971; Harley, 1971). In Fiji, its performance has been rather poor due to its susceptibility to local predators and diseases. In Australia, though inital liberations did not prove successful, but subsequent introductions in 1939 gave enough evidence of its capability to destroy lantana shoots and flowers to a very useful extent under favourable conditions. In fact, Australia has been the main source of subsequent introduction in most of the Asian countries, including India.

The bug sucks the sap of the leaves which becomes discoloured and blackened from the apex and the sides. It then gets curled up and drops off, when dry, leaving the shoots leafless and ultimately leading to die-back. Flower-buds and flowers are invariably attacked even before the inflorescence opens and also when in full bloom. The whole flower head is killed before seeds are formed. Heavy infestation may lead to complete defoliation, resulting in temporary recession in growth as well as checking the spread of the weed to newer areas. This by itself, however, does not cause death of the plants as reported by Joshi (1969).

(v) The Chrysomelid leaf miners, *Octotoma scabripennis* Guer. and *Uroplata girardi* Pic. (Coleoptera : Chrysomelidae) : *Lantana* is known to act as host-plant of atleast eight

Fig. 1



Map of India, showing localities where different introduced species have released by ForestResearch Institute during the last three decades.

species of Hispines, including four species of *Octotoma* and two species of *Uroplata*, but with the exception of *O. scabripennis* Guer. and *Uroplata girardi* Pic., not much is known about the extent of host range and their impact on lantana weed by other species. The studies carried out by Harley (1969) at the Department of Agriculture, Hawaii, clearly indicated that both these species were restricted almost entirely to *Lantana camara* and that both could play very useful role in the bio-control complex of introduced insects. Subsequently these insects were introduced to Australia. Introduction into India by F.R.I. in 1971 have followed their success in Hawaii and Australia.

Both the adults and the larvae feed on leaves and cause severe damage to the foliage. Whereas, the adults of both the species feed on the upper surface, destroying the epidermis and mesophyll, leaving the lower epidermis intact, the larvae are leaf-miners, feeding on leaf tissues

inbetween the layers of epidermis, excavating blotch mines, with inter-connected mined galleries. The damage caused by the feeding of larvae and adults is often very intensive and often leads to total destruction of the leaves. Adults of *O. scabripennis* are larger than those of *Uroplata girardi*. Whereas the former makes one or two mines the latter species (*U. girardi*) makes 2 3 mines, per leaf. The most significant aspect of these beetles is their seasonal activity, which is out of phase with the activity of other defoliators (Lepidoptera and Hemiptera) and can therefore, have an additive effect of defoliating insects at present in use against the host-plant. Also, whereas *U. girardi* favours cooler semi-shaded conditions, *O. scabripennis* can withstand host exposed situations. Both these species are also free of parasites and predators.

Extensive field release operations have been conducted by F.R.I. in several localities, covering many States all over India. About 15,000 beetles of *U. girardi* have so far been released at different intervals in nearly 38 attempts in and around Dehra Dun and some other localities, such as Haldwani (U.P.), Jammu (J&K), Hissar (Haryana), Jabalpur, Bhopal (M.P.), Trichur (Kerala) and Siliguri (West Bangal). Similarly, *O. scabripennis* was released in nearly 38 attempts in and around Dehra Dun (Doon Valley), Haldwani, Bhimtal (U.P.), Jammu (J&K), Bhopal and Jabalpur (M.P.), Trichur (Kerala) and Bangalore (Karnataka). These include multiple releases and repeated attempts in some localities.

Though both these species have been declared safe and released in the field, but there is no evidence of their establishment and dispersal to new areas. This may be because of the restricted movement of the larvae in the mines and their inability to achieve maturity before the leaf fall under certain climatic conditions.

(vi) Stem and root borer, *Plagiohammus spinipennis* (Thoms) (Coleoptera : Cerambycidae) : Among the natural enemies of lantana, collected by Koebele in 1902 during his search for biocontrol agents in Mexico, was a Cerambycid stem borer (probably *Plagiohammus spinipennis* (Thoms) (Perkins and Swezey, 1924). Though introduced into Hawaii in 1902, the insect could not establish untill much later, in the year 1953-54, from the material sent by Mann (1954) and Krauss (1954), and finally released in 1960 (Harley and Kunimoto, 1972). From Hawaii, it was introduced into Australia in 1966 and liberated for lantana control in 1967. In November, 1972, a consignment containing 20 live pupae were imported into India from Forestry Commission, N.S. Wales, Sydney, but no emergence could take place.

A native of Central and South America, this insect thrives well in areas having minimum of 1250 mm rainfall. In fact, total annual rainfall and its distribution are the critical considerations for the survival of the insect species, achieving high population level. This can be a guide to the suitability of a locality for release and colonisation of this species. Droughty conditions result it unthrifty plants and high mortality. Oviposition occurs on the stem. The larvae bore into the stem, which varies according to the size of the plant. In small plants, it girdles plants with *ca.* 1.10 cm diameter (affecting more than 50% plant population). In larger plants,

the same level of infestation occurs in plants with about 3 cm diameter and is less than fifty per cent in plants with still higher stem diameter. The adult beetles feed on the foliage, but the damage caused is not significant. The life cycle is annual. The female beetle displays a very high degree of specificity in its oviposition behaviour and is restricted to *Lantana camara*. The young larvae girdle the stem usually between 15-60 cm height, causing swelling around the wounded portion and bores down to the stem and roots. The borer girdles the stem more than once and incidence of attack tends to increase with increase in stem diameter to a certain extent. The girdled stem readily breaks off, reducing the large plant to a mutilated stump, eventually bearing small regrowth shoots. Extensive experimentation carried out in Hawaii and Australia have indicated that the oviposition by the beetle on teak, though low, but was quite frequent under simulated conditions in cage experiments. However no oviposition occurs on teak in the field, where the host-plant (*Lantana camara*) is available in abundance (Harley, 1971).

High biotic potential and climatic adaptability make this species an ideal biological control of the weed. It is very destructive to host and even at low level of attack is capable of exercising controlling influence, if maintained for several years. The species is an ideal candidate for reintroduction in India to reinforce the existing spectrum of natural enemies of the weed.

(vii) The Tingid Bug, *Leptobyrsa decora* Drake (Hemiptera : Tingidae) : *Leptobyrsa decora* another tingid bug, (strain from Peru and Colombia) which had exhibited outstanding potential in Australia, was imported by the Forest Research Institute in 1976. The first two batches of introductions (April-May, 1976) were unsuccessful (consignments reeeived with dead material). Special care was therefore, taken while receiving the third consignment (Dec., 1977), at Bombay Airport, ensuring safe transit journey to Dehra Dun (Misra, 1985), where host-specificity tests were conducted. The bug was exceptionally receptive and thrived well in simulated out-door cages under Indian conditions, thus exhibiting enough evidence of its potentiality to withstand the adverse climatic pressure of Doon Valley. However, the whole lot was destroyed in 1981, after extensive host-specificity tests conducted with as many as 34 plant species, belonging to 25 families, including teak, as it was found that not only the bug fed on the teak but could also complete its life cycles consecutively for two generations on teak leaves uuder hunger-stored conditions (Sen-Sarma and Thapa, 1981; Mishra and Sen-Sarma, 1986). These observations are quite in contrast to the one reported for its performance in Australia where under simulated conditions for host preference, the bug was found highly host-specific to lantana. Though it did attempt to feed or oviposit on several non-host plants, including teak in high population trials, but the damage caused was much less in severity than the lantana (Herley and Kassulke, 1971). In normal low insect populations trials, the nymphs either failed to feed and died in the first instar stage or if it did feed, the second instar stage. In all trials, the above authors observed that *L. decora* consistently fed

and oviposited on *Lantana camara* causing very heavy damage by way of defoliation. Obviously, the above observations on the diverse behaviour of the bug in the two countries are due to the test conditions followed by the respective workers. Keeping this in view, we are inclined to opine that the bug deserves another trial under Indian conditions, as in was done earlier in 1941 in case of *Teleonemia scrupulosa*, a sister tingid bug and with which it displays very close resemblence in oviposition and some aspects of feeding behaviour. However, whereas the bug *T. scrupulosa* prefers young and tender lantana leaves, the *Leptobyrsa decora* prefers mature and hard leaves and can successfully thrive under shade moist conditions of forest canopy. This contrast feeding trait can be exploited to the serious disadvantage of the lantana and utilize these sister bugs as complementary biocontrol agents.

Whereas the nymphs feed gregariously on the lower surface of both young and mature leaves, the adults feed either singly or in groups usually on the lower surface and occasionally on the upper surface as well. The oviposition and subsequent hardened secretion deposition, though may not cause distortion in leaves, but can cause chlorosis, leading to death of the leaves. The leaves first become chlorotic, then silvery and finally the whole plant may suffer heavy defoliation.

(viii) The lantana fruit borer, *Epinotia lantanae* (Busk) (Lepidoptera : Tortricidae) : The lantana fruit (berry) borer, *Epinotia lantanae* (Busk) was introduced into Hawaii from Mexico in 1902 and to Australia in 1941 (Julien, 1982). Its introduction in India remains obscure. Muniappan and Viraktmath (1986), during their recent surveys in and around Bangalore, Coorg (Karnataka) and Pondicherry, discovered this species from berries of lantana. The larvae were observed boring the berries and receptacle of lantana. The continuous boring by the larvae makes the berries hollow and used as shelter by them. The pupation occur inside the berries.

(b) **Indigenous lantana insects**

Most of the 400 and odd insect species, recorded from lantana, during the survey of lantana fauna (Beeson and Chatterjee, 1940), were found to occur only in small colonies, comprising of individuals limited in number, but several species of defoliators, flowers and fruit feeders were found regular breeders on lantana.

Inspite of the fact, that most of the species are polyphagous and offer very little hope of succeeding in local destruction of the lantana, some of them still hold out a promise of playing a limited role in checking the proliferation and further spread of the weed. Individually, they may be insignificant, but if employed in combination with other ecologically compatible species, may check the spread of the lantana in pockets of some climatic zones in Peninsular India. It would therefore, be purdent to list these species for future considerations.

(ix) The lantana gall-fly, *Asphondylia lantanae* Felt. (Hymenoptera : Cecidomyiidae) : The lantana gall fly, recorded and described by Felt (1920) from specimens collected on lantana in India, is restricted in

Table 2

Indigenous Lantana Insects having good potential as Biocontrol Agents.

Order/Family	Name of species	Localities of species	Period of releases	No. of releases	Total No. of insects released	Remarks
1. Order : Hymenoptera Fam : Cecidomyidae	*Asphondylia lantanae* Felt. (Lantana gall fly)	Hilly tracts of South India.	Destroys flowers & inhibits seed production			*Lantana indica* acts as alternate host.
2. Order : Lepidoptera Fam : Noctuidae	*Hypena* sp. (Near *abyssinalis*) (defoliator.)	Common in South India.	Larvae feed on flowers and skeletonize the leaves.			Heavy rains in Western Ghats adversely affects the population. Needs to be introduced and disseminated to new areas.
Fam : Tortricidae	*Archips miceana* (Walk.) (*Homona micceana*) (borer on ripe fruits)	Oriental species from India to Borneo & Java	Polyphagous species			

distribution to the hilly tracts of South India where it destroys large percentage of flowers and inhibits seed production (Rao, 1920). The indigenous lantana species, *L. indica* is an alternate host.

(x) *Hypena* sp. (near *abyssinialis*) : This species is common in South India and has been reported by Rao (1920). The larvae feed on flowers and skeletonize young leaves of lantana but the feeding potential is greatly hampered because of heavy rains, which adversely affect the population build up of the species during the monsoon months. The other species, *H. strigata* (Fabr.), unlike its sister species (mentioned above) has a very wide distribution from Africa to Australia through Indo-Malayan region. Having been introduced from Africa to Hawaii, this insect has naturalised in the Island, causing heavy defoliation die-back in lantana. However, it has failed in Australia, probably because of high parasitism by a wide variety of parasites. There is a need to conduct extensive surveys in North-west and Indo-gangetic plains in India. If found successful, may be exploited for biological control of the weed.

Discussion and future strategies

Notwithstanding all the research efforts to contain the spread and encroachment of new areas by lantana during the last nine decades, the weed has defied man and continues to be one of the most challenging problems of the 20th century the world over. The problem has attained a global status and is competing man for every inch of the available space under most of the agro-climatic zones of the world, particularly in drier areas. Mechanical control and use of weedicides, of their own have not met with any reasonable success. Attempts to employ bio-control agents, particularly exotic natural insect enemies, mostly from tropical America, have also met with little or only partial success. Most of the insects, considered as potential bio-control agents under simulated experimental trials and causing severe damage to weed are known to have performed very poorly in the field. They have either failed to establish or have not achieved the desired level of success, primarily because of the adverse environmental conditions and high percentage of parasitism from the endemic fauna.

In India, though some degree of success has been achieved with the introduction and establishment of some natural exotic enemies, the lantana continues to be a menace and is spreading uninterruptedly, encroaching newer areas. Unfortunately research efforts on the biological control of the weed have been rather sporadic and half hearted, ever-since the surveys conducted by Rao (1920). Most of the exotic insects have been introduced by the Forest Research Institute, Dehra Dun and lately by the erstwhile Commonwealth Institute of Biological Control, Bangalore. So far, about a dozen introductions have been carried out, involving seven species of insects, comprising stem borers, flower and fruit feeders, sap suckers and defoliators. Among the principles, applied in any biological control strategy, is not only the importation and colonization of the exotic natural enemies of the weed, but also the selection of the species, most suitable in the operation. Time is now ripe to have a fresh look on the performance of the species introduced so far, before addressing

ourselves to the whole question of lantana problem. Should we go in for more introductions of new material of the species already introduced and tried or should we go in for other species from countries, where they are performing well, with promising results.

For any introduction of the natural exotic insect of lantana, the primary emphasis should be on those insects which damage and destroy (i) the stem and root, (ii) the flowers and the fruits and (iii) the foliage. in that order (Mishra and Sen-Sarma, 1986). In our opinion, among the candidate species, with proven track record of suppressing the lantana weed, the stem-boring cerambycid beetle, *Plagiohammus spinipennis* (Thoms) has already shown encouraging results in Hawaii and South Africa. Therefore, in spite of initial failures, this species should be imported and screened for host-specificity tests in India. If found safe, it is a species, which can perhaps play a significant role in arresting further prolification in patches of old lantana bushes in which the stem diameter has reached minimum of 2.5 cm. The next group of insects, deserving attention, are tingid bugs. Data collected so far in India and other countries indicate that the tingidae are relatively free of parasites and predators and hence, are unlikely to face any severe competition and depression from the endemic fauna. This is borne by the fact that species of tingids, because of high biotic potential, have established with high populations in several regions of the world. All the tingid species, exploited so far, have exhibited preference for *Lantana camara* and good tolerance to the alien climatic conditions. They can operate complementarily as an efficient species complex for bio-control agent of lantana (Harley and Kassulke, 1971). In India, among the species tried so far, *Teleonemia scrupulosa* has proved a valuable bio-control agent as it has succeeded in establishing over a wide range of ecological and varied land-use situations and is highly host specific, a trait, which may also be a limiting factor for its slow dispersal and dissemination in newer areas. In spite of the fact, that the species has been in India for well over four decades. there are still many areas in the country. where this species has yet to reach (Muniappan and Viraktamath, 1986). *T. scrupulosa* population collected from diversed habitats, scattered over-extensive geographic ranges, should be imported, propagated and liberated to mingle with long established population of the species. Such stock are known to possess reproductive compatibilities and indulge in general inter-breeding between populations, as a result of highly expanded gene pool. This may prove to be more effective bio-control agent of lantana in the years to come.

There are two more species of tingidae, which have been introduced into Australia from South America and have established with a good degree of success. These could be candidates for introduction. One of these, *Leptobyrsa decora*, had been tested against 34 plant species, including five species of verbenaceae, and has been reported to breed on teak in "*non-choice trials*" (hunger-stress). In our opinion, this species having a genetic constitution suitable to control *Lantana camara* and the diversed Indian climatic conditions, may be given another chance and studied under simulated limited choice conditions, because nothing much adverse has been reported from Australia

against this species even after two decades and that in all host-preference trials, this species has been found highly host-specific It feed and oviposit on *Lantana camara* and causes very heavy damage. Though it has been found to feed and oviposit on teak and several other non-host plants under high population trials, such as sesame and jacaranda, etc., but then damage is much less severe than to lantana and laying only very few eggs. The other tingid bug *Teleonemia elata* possesses highly specialised feeding and oviposition behaviour and is highly host-specific, which may be of an even higher order than that of *T scrupulosa*. Trials in Australia have indicated that limited feeding and oviposition may occur on teak or sesame, but then several other insects specific to lantana, also attempt to feed and oviposit on these plants even when they are growing in the field in close proximity to lantana heavily infested with *L. decora*. However, the nymphs do not survive on these plants and the damage caused is only of transient nature. Both these tingid species have been released for control of lantana in Australia and from there to Hawaii and Zambia. *L. decora* is now well established in Hawaii. Next in order of importance comes the lantana leaf mining chrysomelid beetles, *Octotoma scabripennis* and *Uroplata girardi* and the plume moth, *Lantanophaga pusillidactyla*. These species have been released after having been found safe in host-specificity experiments at the Forest Research Institute. The beetles were released in Dehra Dun, Haldwani and Bhopal between 1972-75. There has been lack of feed back and monitoring their performance, this is probably because of lack of dissemination to new areas, particularly in South India and some other parts of the country. However, in view of successful establishment in Australia and Hawaii, there is a scope of introduction and spread of these beetles in areas climatically similar to that of Australia and Hawaii. Regular culture of *Octotoma scabripennis* is being maintained at Forest Research Institute, which may form the focal point for futher releases to newer areas, particularly in drier parts of peninsular India.

Seed boring insects, *Ophiomyia lantanae* and *Epinotia lantanae* are capable of providing a reasonable check in the dispersal of the weed through seeds. *O. lantanae* is widely distributed, and has been reported from most parts of the country, but it has failed to control the weed. *E. lantanae* occurs only in pockets in Karnataka. A full potential of this species needs to be exploited and introduced to Northern India and other localities (Muniappan and Viraktamath, 1986). Similarly, though initial attempts to establish *Selbia* (*Syngamia*) *haemorrhoidalis* and *Diasterna tigris*, having failed in India, requires another trial. These insects needs to be reinvestigated for their potentiality against the weed under Indian conditions. This is particularly true for the former species, which has established well in Australia, Fiji, Hawaii and Mauritius (Water House, 1985) and causing wide spread damage to lantana by way of defo iation in Hawaii.

Some of the bio-control species, though well established in some parts of the country, *e.g.*, *L. pusillidactyla*, *A. lantanae* and *Hypena* spp., may be slow in dispersal for various reasons, needs to introduced and disseminated to new areas, where they may

even prove more effective under new environment. Apart from the insect species mentioned above, some natural enemies can still be considered as candidates for importation from Australia or elsewhere, where they have proven record of excellent performance. For example, dipterous leaf minor, *Coleomyza lantanae* (Frick) (Diptera : Agromyzidae) in Australia. and *Neogulea* (*catabena*) *esula* (Druce) (Lepidoptera : Noctuidae) have shown promise of becoming an important bio-control agents in some localities in Hawaii. These species can be strong candidates for introduction to strengthen the regime of introduced bio-control agents in India and release after the usual host-specificity tests.

Future Strategy

Biological control of weed is a long term activity and which, in certain situations, may even take decades before any significant break through achievement is discernible. This is what has been observed in Australia, Fiji and Hawaii islands, where concerted efforts, well over half a century, have yielded only partial success. In India, though the dimensions of the problem are fully realised, but our efforts in this direction have not been matching the magnitude of the weed problem primarily because of lack of appreciation of the problem by the policy makers and planners. There is every reason to be optimistic about the eventual successful biological control of lantana, for that matter even other noxious weeds, such as *Chromolena, Eupatorium,* and *Mikania* in India, provided concerted and sustained inputs for research, training and extension are made available (Mishra and Sen-Sarma, 1986). For this, a well coordinated all India "*Lantata Eradication*" programme has to be chalked out and executed through the cooperation and involvement of various agencies, such as forest departments, social organisations (for people participation), researchers, and above all political and administrative patronage. For this, the following integrated approach is suggested. The major aspect of such an integrated strategy is the mechanical removal of the weed, followed by the treatment of area by weedicides and subsequent inflow of the natural enemy complex.

(i) *For cultivated land* : Intensive cultivation by the farmers under agricultural cropping system can check the invasion by the weed on the cultivated fields, to a great extent. Lantana along the boundaries of the fields should be cut down regularly and burnt. If necessary, application of weedicides may also be carried out by way of cut-back open land or foliar spray, preferably in summer months after the rabi crop and well before the rains.

(ii) *Wastelands* : For afforestation and reclamation of wastelands, already invaded by lantana, the area should be cleared off of all lantana bushes and burnt by controlled fire, preferably during summer months (*vide supra* under (i) when the lantana is leafless and heaps of dried foliage get accumulated on the ground to facilitate burning. The area should then be treated, avoiding the planting pits, with weedicides, such as Bladex-II @ 3 lit/ha or Spontox @ 5 litres/ha, in 1000 litres of water emulsion. The treatment may be repeated after 7-8 weeks. Depending upon the climatic zones, the area should then be planted with beneficial and economically

important species of grasses, herbs, shrubs and plantation species, such as *Sacchrum arundinacea*, *S. munja* and *S. procera*, *Erythrina stricta* (For N.E. India), *E. subrosa* (Northern India) and *E. lophosperma* (Peninsular India), *Broussonetia papyrifera*, *Dendrocalamus strictus*, *Leucaena leucocephala* and *Kutzoo vine*, etc. These and some other plant species can outgrow and overshadow the lantana thickets, thus limiting its scope for further spread. These species are also good fodder producers and increase the fertility of the soil. Timber of fuelwood produced can also meet the requirement of the farmers and the local tribal population.

(iii) Regular weeding in forestry plantations is prescribed for atleast initial 3-4 years, to check the reemergence of the lantana in the area. For this, scrapping of *ca.* 1 metre area around the planted seedlings/transplants and hoeing within 0.5 metre radius is generally advised. Then, after a little gap, the area should be inundated with the release of bio-control agents. A combination of ecologically compatible bio-control agents should be worked out and released, targeting different parts of the plant, such as stem and root boring beetles, foliage defoliators, flower and seed feeders, etc., with suitable adaptability to the phenology of the weed, so that the nutural enemies can start feeding on fresh sproutings, thus acting as a check for further proliferation of the weed.

(iv) Though the weed possesses a good quality fibre and is suitable for particle/fibre board, it has no prospect of economical utilization. The main problem is the collection of the raw material with is not cost effective. One way to reduce the collection cost, probably would be to devise a suitable light mechanised mobile thresher for on the spot threshing of the lantana bushes and economical transportation. This is an area which requires further investigation.

SUMMARY

The paper provides a comprehensive review of the Lantana problem in India and its possible management through promising biological control agents and some other viable options. The weed is reported to support well over 400 indigenous insect species, but except for a few species, all are only casual visitors. To augment the indigenous enemy complex, as many as seven exotic species have been introduced and tried for possible successful control agent. Efficacy of these insects has been discussed in the light of their field successes and failures It is concluded that application of weedicides and mechanical control alone have not given reasonable success due to larger areas and cost of weedicides and labour involved. Though, biological control has been considered as the most promising proposition, however only an integrated approach through silviculture-cum-biological control, chemical control, mechanical control, people participation and above all development of any technology for its economic utilization, can help in the eradication of this noxious weed.

भारत में लैण्टाना तृणक (लैण्टाना कैमारा विभेद एक्युलियाटा लि०)
और प्राकृतिक नाशिकीटों द्वारा इसकी सभावित रोकथाम

एम०एल० ठाकुर, मुख्तार अहमद व आर०के० ठाकुर

सांराश

इस अभिपत्र में भारत की लैण्टाना समस्या तथा उत्साहप्रद जैविकीय नियन्त्रण कारकों और कुछ अन्य प्रभावकारी उपायों द्वारा इसकी संभावित रोकथाम की विस्तृत समीक्षा प्रस्तुत की गई है। यह तृणक 400 से अधिक देशज कीट जातियों को पोषित करता सूचित किया गया है परन्तु इनमें से एक-दो जातियों को छोड़कर, शेष कभी-कभार ही दर्शन देने वाली जातियां हैं। इसके देशज शत्रु समूह में वृद्धि करने के लिए सात जितनी अधिक तक विदेशी कीट जातियां बाहर से लाकर छोड़ी और सभावित सफल नियन्त्रण अभिकरण के रूप में परीक्षित की गई हैं। इन कीड़ों की प्रभावकारिता का क्षेत्र में इनको मिली सफलता और विफलता के प्रकाश में विवेचित किया गया है। निष्कर्ष यह रहा है कि मात्र तृणनाशियों और यांत्रिक नियंत्रण उपाय करने से तर्क सगत सफलता नहीं मिल सकी क्योंकि क्षेत्र बहुत बड़े और तृणनाशियों का दाम और उन्हें उपयोग करने की मेहनत बहुत अधिक रहती है। यद्यपि जैविकीय नियन्त्रण को सबसे अधिक उत्साह द उपाय स्वीकार किया गया है, फिर भी वन सवर्धन-सह-जैविकीय नियन्त्रण, रासायनिक नियन्त्रण, यांत्रिक नियन्त्रण, जनता का सहयोग इन सबको मिलाकर एकीकृत दृष्टि अपनाने से ही इस हानिकर तृण जाति को निर्मूल करने में सहायता मिल सकेगी।

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THREE DECADES OF FOREST GENETICS AND TREE IMPROVEMENT

C.J.S K. EMMANUEL, M.L. KAPOOR AND V.K. SHARMA

Division of Genetics and Tree Propagation,
Forest Research Institute, Dehra Dun (India)

Introduction

Tree improvement work in India was started by Prof. Champion who realised the importance of geographic variations and conducted a seed origin trial of teak during 1930. Later on in 1951 Dr. Rao published an article on Genetics and Tree Improvement. Realising the importance of this subject Forest Research Institute, Dehra Dun opened a Forest Genetics Section during 1959-60 attached to Botany Branch under the then Directorate of Biological Research. In the year 1961 Prof. J.D. Mathews an expert from F.A.O. visited India to give guidelines for the proposed work. He suggested initially to work on some priority species viz. *Tectona grandis*, *Bombax ceiba*, *Pinus* spp., *Dalbergia sissoo*, *Santalum album*, *Morus alba* and *Pterocarpus santalinus*. On the recommendations of the 2nd Expert Committee on Forest Research Institute, Genetics Section was elevated to the status of a Branch in 1969-70. The work got an impetus during the V Plan period when two central sector schemes started functioning. The first one in collaboration with DANIDA as 'Indo-Danish Project on Seed Procurement and Tree Improvement' with its headquarters at Hyderabad and a centre at Dehra Dun, Hyderabad and Coimbatore. The objective of the scheme was to provide seeds for forest plantation from selected and registered seed sources of indigenous species within their regions and to provide assistance for seed procurement of exotic species. This main task included the necessary testing of seed and source material under a tree breeding programme aiming at mass production of genetically improved seed. The second scheme was 'Creation of Radio Isotope Laboratory facilities'. The objective of the study was to work on physical and chemical mutagenesis of forestry species, calculate the LD-50 dose and screen out variants for future tree breeding work.

In 1988 reorganisation of Forest Research Institute took place and a Division of Forest Genetics and Tree Propagation was formed by merging Forest Genetics Branch, Indo-Danish Project on Seed Procurement and Tree Improvement Centre, Dehra Dun and Radio Isotope Laboratory. After the formation of this division seven projects have started functioning under it for the improvement of some selected species viz. *Acacia nilotica*, *A. catechu*, *Albizia* spp. *Azadirachta indica*, *Bombax ceiba*, *Dalbergia sissoo*, *Eucalyptus* spp., *Prosopis cineraria*, *Pinus roxbughii*, *P. wallichiana*, *Robinia pseudoacacia*, and *Tectona grandis*. Under the umbrella of Indian Council of Forestry Research and Education, Institute of Forest Genetics and Tree Breeding started

functioning at Coimbatore besides this, three other institutes have genetic division.

Achievements

The research work conducted since inception of Forest Genetics Branch till date are briefly described under the following heads.

(a) Exploitation of available Natural Genetic variability within the species :

(i) *Plus tree selection* : Plus trees are the superior phenotypes selected from natural forests or plantations. This is the first step for starting any long term tree improvement programme to produce genetically superior seeds on mass scale. Based on the assessment of commercially important forest tree species for their end use selection criteria were prepared for candidate trees and their approval as plus trees (Mathew, 1961; Muniswamy, 1978a; Bagchi, 1983) for a number of species viz. Teak, Semul, Shisam, Chir, Kail, Deodar, Fir, Spruce, *Prosopis*, *Acacia* etc. These guidelines were circulated to the State Forest Departments for intensive survey and selection of candidate trees. These trees were later on screened for the selection of plus trees on comparison with check trees on the basis of growth, vigour, form, fruiting, resistance to insect/pests, forest produce and other characters. In collaboration with State Forest Department approximately 1200 plus trees have been selected (Kedharnath, 1967; 1982; Rai, 1986; Emmanuel and Bagchi, 1988) for different species, prominent among them are *Tectona grandis* 714, *Bombax ceiba* 62, *Dalbergia sissoo* 53, *Gmelina arborea* 60, *Pinus roxburghii* 186, *Santalum album* 30 and *Pterocarpus santalinus* 258.

(ii) *Seed Stand/Seed Production Area* : It is the quickest method of producing genetically improved quality seeds to raise new plantations with increased productivity. To select seed stands of important forest tree species criteria were prepared (Mathew, 1961; Rawat, 1983; Nayal and Rawat, 1984) and circulated among the State Forest Departments. Approximately 15,000 ha have been selected (Rai, 1986; Thapliyal *et al.*, 1988) for different species prominent among them are *Tectona grandis* 9358.862 ha, *Bombax ceiba* 67.9 ha, *Pinus roxburghii* 2934.2 ha and *Eucalyptus* sps. 99.44 ha. Survey conducted on seed requirements for different species have shown that in case of teak (Srimathi and Emmanuel, 1986) States using seeds from Seed Production Areas require 2.5 kg seeds to raise one hectare of plantation, where as from other sources 10 to 40 kg seeds per hectare was required. This shows that gains are obtained both genetic and economic when seed from seed production areas is used to raise new plantations.

(iii) *Seed Orchards* : To produce genetically superior seeds on mass scale, seed orchards are developed from the clonal material. State Forest Departments interested in this work were helped to establish seed orchards by providing necessary assistance for vegetative propagation techniques, planting designs etc. (Venkatesh, 1981; Vakshasya and Rawat, 1985). One pilot seed orchard for demonstration was established with 20 clones of teak at New Forest, Dehra Dun. Two seed orchards of *Bombax ceiba* were established in Uttar Pradesh (Venkatesh and Sharma, 1980) and it was found out that orchard developed at warmer area produced more seeds as compared to colder frost affected areas.

Studies have also been conducted to find out combining ability of different *Bombax* clones. Progeny raised from the crosses between J×I clones was found superior over others. Two biclonal seed orchards have also been raised at New Forest, Dehra Dun with high yielding and frost resistant characters. So far 467.172 ha of seed orchards have been established for teak, semul and sandal (Rai, 1986).

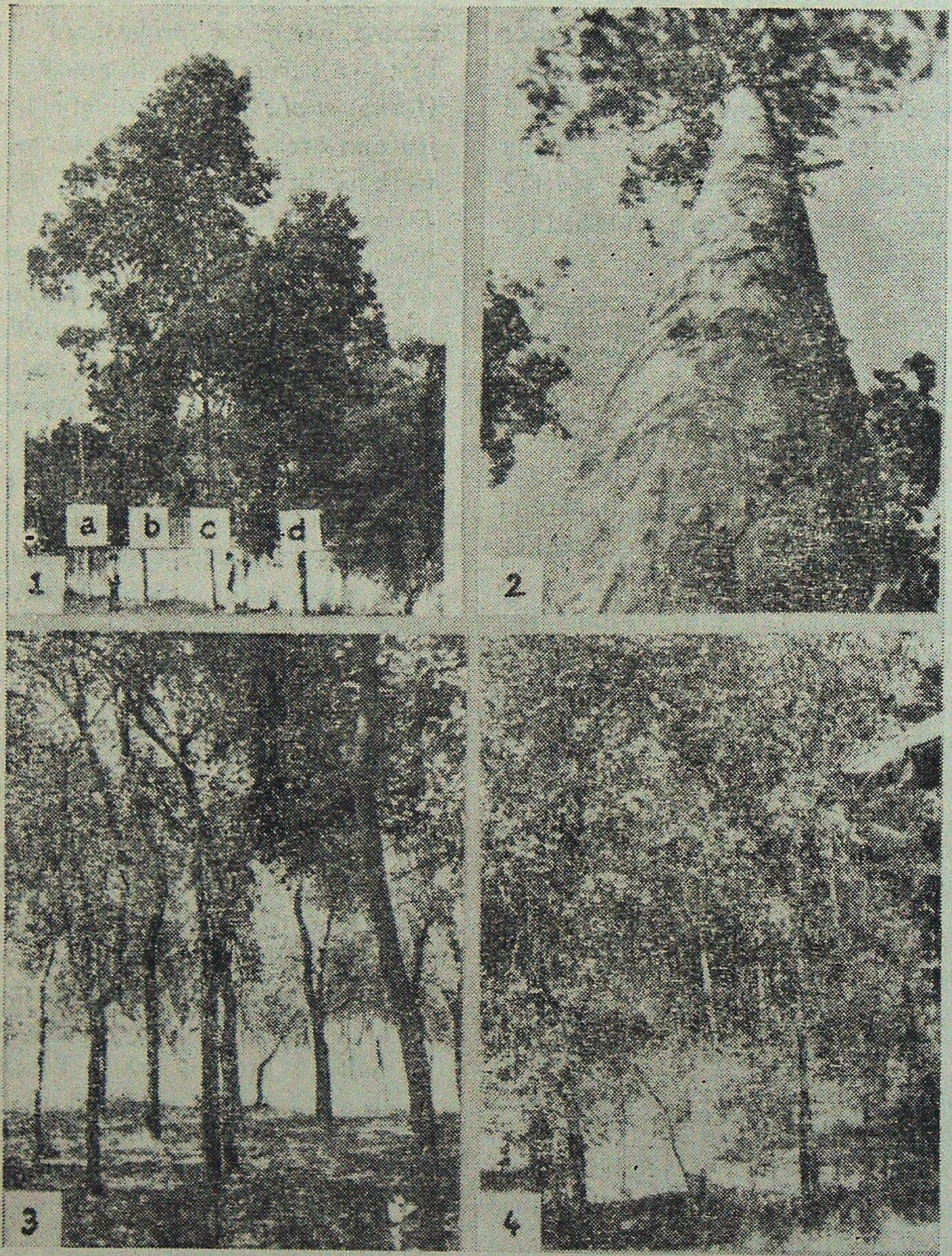
(iv) *Other variations* : Variation is the key factor in any tree improvement programme. Some natural variations observed while working on tree improvement projects of teak, semul, chir pine, sandal, eucalypts and red sanders have been recorded. The important ones are polyembryony seed and seedling variations including chlorophyll mutants as genetic markers (Venkatesh and Emmanuel, 1976; Bagchi and Emmanuel, 1984; Vakshasya and Emmanuel, 1984; Shrimathi and Emmanuel, 1984), phenological and morphological variations (Venkatesh and Sharma, 1977). With regards to anatomical and wood characters (Vakshasya *et al.*, 1988) and insect resistance.

(v) *Germplasm collection* : The aim of germplasm collection is to conserve the range of variability found in a particular species in respect of various easily recognisable characters as well as other valuable genotypes. Germplasm banks established at New Forest, Dehra Dun are of *Tectona grandis* (20 clones) and *Bombax ceiba* (15 clones). Assistance have been provided to establish *Tectona grandis* germplasm bank in Arunachal Pradash with 130 clones and in Karnataka with 118 clones.

(vi) *Provenance trials* : Nature has provided vegetation to suit different types of climates, soils and environments. With the increasing pressure on land it has become essential to choose particular provenance which suits best to a particular environmental condition (Rawat *et al.*, 1987) to obtain higher yield per unit area. The species on which some work has been done are Teak, *Bombax* and *Eucalyptus*. In *Eucalyptus camaldulensis* it was observed that the latitude of the seed origin is correlated with same economic traits studied on twelve Australian Provenances (Vakshasya, 1988; Venkatesh and Vakshasya, 1979). In *Bombax* Assam provenance has shown better performance than local once at New Forest, Dehra Dun. The ongoing provenance trials are on *Dalbergia sissoo* with 27 provenances distributed to 13 States (Vakshasya *et al.*, 1988), *Pinus wallichiana* with 30 provenances distributed to four States, *Azadirachta indica* with 25 provenances and *Acacia nilotica* with 30 provenances. Besides this a species trial of *Acacia* has been laid out at New Forest comprising of 23 different species.

(vii) *Progeny Trials* : After the selection of superior phenotypes they are tested for their genetic worth whether they are capable of transmitting their good traits to their progeny or not. This is tested by laying out full-sib or half-sib progeny trails. Based on these trials a plus tree is approved as an elite tree or and a clonal seed orchard is rouged or an advance generation seed orchard is established. Progeny testing studies have been carried out and hestability estimates for some characters have been reported for teak, semul, eucalypts and sandal. In case of teak half-sib analysis was done by Kedharnath *et al.* (1960) have calculated broad sense heritability for height, girth and number of

Plate 1



1. *Eucalyptus* hybrids showing hybrid vigour growing in the field along with parent species.
   (a) *E. citriodora* (b) F_1 *E. citriodora* × *E. torelliana*
   (c) F_1 *E. torelliana* × *E. citriodora* (d) *E. torelliana*
2. Plus tree of *Eucalyptus*
3. A view of field trial of diploids, triploids and tetraploids of Mulberry (*Morus alba*).
4. Colchicine induced autotetraploids in Sandal (*Santalum album*).

Plate 2

1. A view of provenance trial of Semal laid out at New Forest, Dehra Dun.
2. Progeny trial of plus trees of teak.
3. Close-up view of progeny trial of plus trees of teak showing variation in bole diameter and clean-bole length.
4. Varietal trial of *Leucaena leucocephala*.

internodes as 1.00, 0.88 and 0.91 respectively. Both half-sib and full-sib progeny trials were laid out for *Bombax* (Venkatesh, 1969). Half-sib progeny trials were also conducted for *E. tereticornis*, *E. camaldulensis*, *E. grandis* (Venkatesh and Vakshasya, 1977 and Kedharnath, 1982) and *Santalum album* (Bagchi and Kulkarni, 1987; Bagchi *et al*, 1987).

(b) Exploitation of Induced Genetic Variability :

(i) *Induced Mutagenesis* : To study the radio and chemical sensibility more than a dozen species have been treated with continuous and fractionated doses of gamma rays and/or chemical mutagens viz. NMU, EMS and Hydrazine hydrate at different moisture levels (Kapoor, 1981). Phenovariants have also been identified in *Albizia procera*, *Dendrocalamus strictus* and *Populus deltoides*. In case of *Albizia procera* they are superior in growth as compared to control, in *Dendrocalamus strictus* flowering has been induced at the age of 15 montns, and in case of *Populus deltoides* they are superior in growth as compared to control (Kapoor and Sharma, 1983).

(ii) *Induced Polyploidy* : Techniques for the induction of tetraploidy were standardised for *Eucalyptus tereticornis*, *Dalbergia sissoo* *D. latifolia*, *Morus alba* and *Santalum album* and tetraploids were developed (Kapoor and Kedharnath, 1970, 1973; Kapoor, 1981). The tetrapliods were compared with diploids in respect of various morphological and growth parameters, cytological investigations were also carried out. In mulberry autotriploids were also produced and a trial was laid out to compare the growth of diploid, triploid and tetraploid. Recently allotetraploids *E. tereticornis* × *E. grandis* were crossed with diploid *E. tereticornis* and *E. grandis* to produce Allotriploids. These allotriploids have shown faster rate of growth during nursery stage. This is first report of its kind in this genus.

(c) Hybridization :

In *Eucalyptus* control hybridization work was carried out involving different parent species combinations to explore the possibility of exploiting hetero sis (Venkatesh, 1973) and also to combine the desirable traits of the two parent species. Based on crossability pattern, the species selected were *E tereticornis*, *E. camaldulensis* and *E grandis*. Control crosses were attempted between *E. tereticornis*, × *E. camaldulensis* (designated as FRI-4) and *E. tereticornis* × *E. grandis* (designated as FRI-6) and F_1 hybrids were produced (Venkatesh and Vakshasya, 1977). Spontaneous natural F_1 hybrids of *E camaldulensis* × *E. tereticornis* (FRI-5) and *E. grandis* × *E. tereticornis* (FRI-10) were also picked up based on marker characters (Venkatesh and Sharma, 1979). Apart from this spontaneous hybrids of *E. citriodora* × *E. torelliana* and *E. torelliana* × *E. citriodora* were also picked up. The hybrids FRI-4, FRI-5, FRI-10 and *E. citriodora* × *E. torelliana* and *E. torelliana* × *E citriodora* have displayed very high degree of heterosis and produced 3-5 times more volume than the parent species; *inter se* comparison between FRI-4 and FRI-5 and reciprocal hybrids of *E. citriodora* and *E. torelliana* was also made (Venkatesh and Sharma, 1976; Kapoor and Sharma, 1983, 1984). These hybrids have shown differential

response in heterosis which may be attributed to cytoplasmic effect of the maternal parent (Venkatesh and Sharma, 1977b). Studies on their morphology, wood properties have also been carried out. A trispecific hybrid *E. camaldulensis* × *E. tereticornis*) × *E. grandis* designated as FRI-13 was also synthesised (Venkatesh and Sharma, 1980). This hybrid did not show much promise so far as its growth is concerned. Nevertheless it is a second report of its kind in this genus. Based on marker characters estimation of inbreeding and effect of inbreeding were studied (Venkatesh and Sharma, 1973). Second and third generation trials of these hybrids have been laid out in the field for further selection.

Hybridization studies were also conducted on *Tectona grandis* × *Tectona hamiltoniana*. The seeds obtained were shrivelled hence no further study could be made.

(d) Vegetative Propagation Techniques :

(i) *Conventional Methods* : Different methods of vegetative propagation viz. grafting, budding and air layering were standardized for *Bombax ceiba*, *Gmelina arborea*, *Pinus roxburghii*, *P. patula*, *Tectona grandis* and *Eucalyptus tereticornis* etc. (Kedharnath and Venkatesh, 1963; Rawat and Kedharnath, 1968; Kedharnath *et al.*, 1976; Kedharnath and Kapoor, 1976; Kapoor *et al.*, 1977; Kedharnath *et al.*, 1979; Uniyal *et al.*, 1985). An interesting observation was noticed particularly in case of cleft grafting in *Eucalyptus*, that homoplastic grafts show graft incompatibility. However, when grafting was done on to ortet root stock the graft grew normally as the autoplastic graft. Graft incompatibility has also been observed while establishing National Germplasm bank of teak and bud grafting scion materiel from different plus trees on to a root-stock of single source (Emmanuel and Bagchi, 1984). However, this technique has great potential and could be utilised for the establishment of germ plasm banks and clonal seed orchards to produce genetically improved quality of seeds.

(ii) *Micro propagation technique* : Recently tissue culture laboratory has been established at Forest Research Institute under this divison. The work has already been started for standardization of technque and formulation of media to develop protocol for mass multiplication of *Eucalyptus* hybrid, *Acacia* sps. and *Albizia* sps. Protocol for micropropagation of *Eucalyptus* hybrid has already been standardized. The plants so developed have been planted in the field (Swarup and Kapoor, 1988; Kapoor and Chauhan, 1990). This technique has great potential and immense value for mass propagation of genetically improved strains/clones for raising new plantations to increase forest productivity.

Inference

During the last thirty years the genetics section has emerged out in the form of a Institute on Forest Genetics and Tree Breeding. Looking to the importace of this subject it has become essential to concentrate more on its expansion by including biochemical genetics, biotechnology and genetic engineering to meet the increasing demand and for the fast changing environmental conditions due to increased pollution.

SUMMARY

The paper summarizes the research work carried out on forest genetics and tree improvement of important forest tree species by Forest Research Institute, Dehra Dun and its sister organizations during the past three decades under different projects/schemes. The species taken up for genetic improvement were *Tectona grandis*, *Bombax ceiba*, *Pinus* spp , *Dalbergia sissoo*, *Santalum album*, *Morus alba*, *Pterocarpus santalinus*, *Acacia nilotica*, *Acacia catechu*, *Eucalyptus* and *Albizia* spp. Different methods of genetic improvement viz. selection, hybridization, induced polyploidy and induced mutageneis, were tried. This task also involved the selection of plus trees, creation of seed production areas, establishment of seed orchards, and laying of provenance trials etc. Apart from genetic improvement, work was also carried on vegetative propagation by budding, grafting, air layering including tissue culture and suitable techniques developed which have great potential for establishing clonal seed orchards and conservation and multiplication of desired novel genotypes.

The significant achievements made in these directions are detailed in this paper.

वन आनुवशिकी एवं वृक्ष सुधार के तीन दशक

सी०जे०एस०के० इम्मेन्युल, एम०एल० कपूर व वी०के० शर्मा

साराँश

इस अभिपत्र में वन अनुसंधान सस्थान, देहरादून और इसकी भगिनी संस्थाओं द्वारा विभिन्न परियोजनाओं/योजनाओं के अन्तर्गत विगत तीन दशकों में वन आनुवशिकी और महत्वपूर्ण वन वृक्ष जातियों के वृक्ष परिष्कार पर किए गए अनुसधान कार्य का सारांश दिया गया है। आनुवशिकी परिष्कार के लिए ली गई जातियां टेक्टोना ग्रांडिस, बाम्बेक्स सीबा, पाइनस की जातियाँ, डलबर्गिया सिस्सु, सैण्टेलम एल्बम, मोरस एल्बा, टेरोकार्पस सैण्टेलिनस, अकेसिया नीलोटिका, अकेसिया केटैच्यु, युकेलिप्टस और एल्बिजिया की जातियां रही। आनुवशिक परिष्कार की विभिन्न रीतियां अर्थात् चयन, सकरण, प्रेरित पुरुगुणता, और प्रेरित उत्परिवर्तीजनन परीक्षित की गई। इस कार्य में श्रेष्ठतर वृक्षों का चुनाव, बीज उत्पादन क्षेत्रों का निर्माण, और बीज उद्यानों की स्थापना, स्थानज परिक्षणों का आयोजन आदि करना भी सम्मिलित रहे। अनुवंशिक परिष्कार के अतिरिक्त, कली बांध, कलम लगा, गूटी बाँधकर जिसमें ऊति-संवर्धन भी सम्मिलित है, वर्धी प्रवर्धन कराने पर भी कार्य किया गया तथा उपयुक्त प्रविधियाँ विकसित की गई जिनकी कृन्तक बीज उद्यान स्थापित करने तथा वांछित नए समपित्रैक संरक्षित और बहुवर्धित कराने में बहुत संभावनाएँ हैं।

इन दिशाओं में प्राप्त हुई महत्वपूर्ण उपलब्धियां को प्रस्तुत अभिपत्र में विस्तार से बताया गया है।

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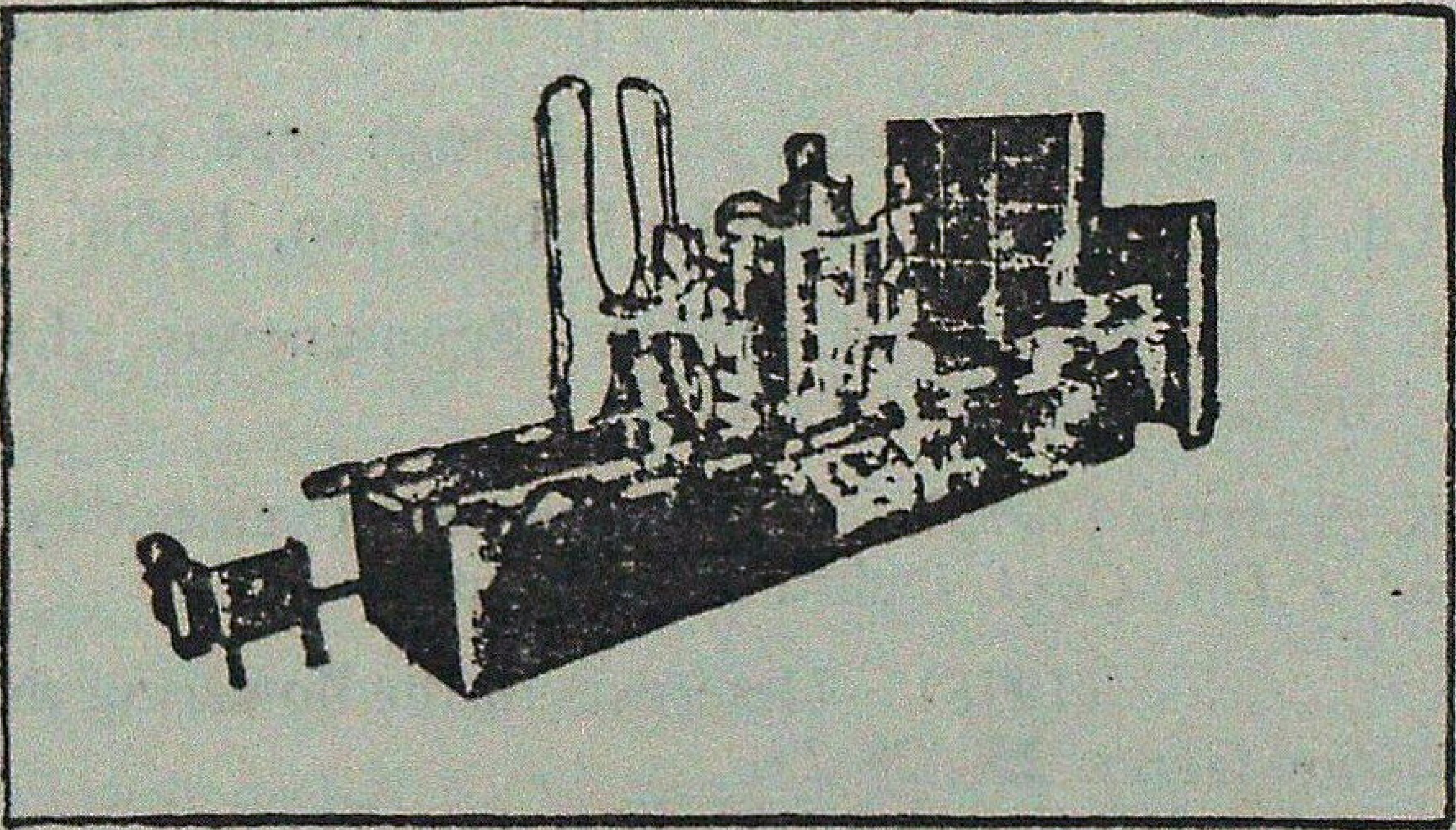

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POLLEN GRAINS IN THE GENETIC IMPROVEMENT OF TREES

C.M. SHARMA
Department of Forestry,
H.N.B Garhwal University, Srinagar, Garhwal (U.P.)

Introduction

For understanding any tree improvement programme, the difference between the tree genetics and the supporting sciences related to it should be stressed clearly. The environmental changes, artificial selection, true mass selection in various progenies and controlled pollination lead to appreciable genetic gains in natural habitat. However, the tree genetic improvement can also suitably be influenced by interfering the natural breeding pattern by applying various hybridization techniques.

It is conceivable that tree genes migrate via pollen or seed. Pollen transfer is gamete transfer and seed transfer is zygote transfer. Immigration of pollen into a hybrid means immigration of genes into the hybrid. Migration of the genes is a one way process. Different pollen species have different migration rate. If the forest stands are dense or if the pollen dispersion distances are great the gene flow is also rapid, the entire population thus remains uniform. As contrast if the population is sparse or if the pollen dispersion distances are small, gene flow is inhibited and the different segments of the population can become differentiated genetically.

Thus there is an alternation of generations in trees from zygote (tree) to gamete (pollen grain) and back to zygote. Selection usually acts on the seed or trees (zygotes), but its effects are transmitted to the next generation through the gametes. It is, therefore, clear that a pollen grain produces gametes and a zygote is the cell formed by the union of the gametes.

The important aspects for tree improvement may be selection and crossing of trees from different geographical origins and production of hybrids with the help of the exotics, polyploidy breeding etc. The pollen grains are involved in each breeding process of tree improvement programmes. Taking it into the consideration, some important methods are discussed briefly, which can be of immense help in tree genetic improvement programmes.

Pollen in tree breeding

The influence of male parent is manifested in F_1 generation as a rule, provided the character is dominant. But in some cases the pollen may produce a direct effect on the parts of seed and fruit (Xenia and Metaxenia). Various effects like shape and size of both fruit and seed, number of seeds per fruit, yield, quality, colour and ripening time of the fruits, have been found to be influenced by foreign pollen. Some important roles of pollen in tree breeding can be summarized as follows :

(a) *Pollen irradiation* : Pollen grains are considered to be the fitest material for irradiation studies. Brewbaker and Emery

(1962) have shown that irradiation sensitivity is related to pollen size. The effect of irradiation is sometimes also reported upto M-2 generation. The effect is more striking in polyploid materials since polyploid gametes can withstand chromosome aberration to a greater extent. than that of diploids (Swaminathan, 1964). Mutations have also been claimed by electromagnetic shock of pollen, however, the detrimental effect of pollen irradiation have been recorded in the form of various cytological irregularities both in pollen, embryo and endosperm (Rick, 1942). Induction of mutation through X-Ray irradiation of flower buds at pollen mother cell stage was one of the earliest successful techniques for the induction of self-incompatibility (Lewis, 1949).

(b) *Pollen cytology and Polyploidy* : Approximately one third of the species of flowering plants are polyploid. This number is so large because hybridization followed by chromosome doubling can and has led to the formation of new species in one generation. Polyploidy was of very little importance in the evolution of *Pinus*, *Picea*, *Abies*, *Quercus*, *Populus* and *Eucalyptus* etc. The naturally occurring species in each of these large genera are similar with regard to chromosome number. But artificial hybridization followed by chromosome doubling and production of triploids by crossing diploids with artificially produced autotetraploids are the other promising applications of polyploidy in tree breeding. It has been particularly more encouraging in *Aesculus*, *Acer*, *Alnus*, *Betula*, *Fraxinus*, *Populus* etc. A few attempts to double chromosome number of pollen in a colchicine solution or by injecting the drug into immature strobili have been successful (Mergen, 1959). Pollen treatment is not a practical method of obtaining polyploid trees, however, the application of polyploidy breeding in the Gymnosperms seems to be very limited.

(c) *Crossability and hybrid production* : By hybridization the crossing of diverse species is done to achieve genetically superior progeny. In forestry crossing of different species is done to enhance the growth rate better than that found in either parent. Combination of favourable traits from two or more different species is another practical goal of hybridization work. A preliminary study of taxonomy of the genus often provides worthwhile clues as to the crossability pattern. For example, in *Acer*, *Fraxinus*, *Pices* and *Pinus* the majority of the successful crosses involve species which had long been recognized as being similar morphologically. Whereas, crosses between unrelated species have usually been ended in failure. Knowledge of natural distribution of the species is also essential for crossability pattern. Repetition of successful crosses, testing and selection leads to genetically superior cross for better hybrids. The intensive studies had been conducted by different workers in the past on crossability patterns and hybrid production on different tree species *Pinus*, *Picea*, *Abies*, *Larix*, *Populus*, *Quercus*, *Castanea*, *Aesculus*, *Acer*, *Eucalyptus* and *Betula*.

Selective pollination

In most species a high percentage of trees do not flower regularly, or, having flowered, they set small amounts of seeds. For controlled pollination, the test should include enough specimens of each family or

provenance that all desirable crosses can be made without a sacrifice in the selection differential for growth characters. In controlled pollination artificial transfer of pollen is done from one flower to another and male and female parent are known with certainity. Usually artificial transfer of pollen grain is possible only when the female flowers are enclosed in bags well before pollination time. Controlled pollination studies are much helpful in species hybridization or racial hybridization and selective breeding programmes (Larsen, 1956; Nienstaedt and Kriebel, 1955).

In controlled pollination the bags are applied one to two weeks earlier to anthesis. The pollination bags are usually removed one to two weeks after pollination. But in *Acer*, *Fraxinus* and some other species it may be advantageous to leave the pollination bags on the branches from pollination time to fruit maturity. This procedure has saved labour and resulted in increased seed sets (Wright, 1953). Emasculation is unnecessary in dioecious genera such as *Fraxinus*, *Populus* and *Salix* etc., but it is rarely necessary in monoecious groups, such as *Acer*, *Juniperus*, *Picea*, *Quercus* and *Pinus* spp. In insect pollinated species pollen is scarce and must be applied by brushing on to each stigma individually. This entails removal of the pollination bag, application of the pollen to the stigmas and replacement of the pollination bag.

In experimental programmes different pollens are applied on the same tree. This necessitates separate labeling of each pollinated branch. The labels should be applied immediately below the pollination bag, so that they apply to all fruit developing distally. The labels need to be inscribed with only one number—a code applicable to a particular pollination procedure on the particular female tree. This number can be punched into the label. Thin copper labels become hard to see after one year, therefore, thin aluminum labels and plastic labels have been used and found satisfactory. The labels are always attached by a wire sometimes to facilitate relocation on of the developing fruit.

Pollen dispersion distance is more critical in most tree genetic work. Small amount of pollen travel hundreds of miles from the nearest land (Erdtman, 1954). Attempts to release artificially collected pollen after the close of natural flowering season have not been successful Reliable counts can be made only if the pollen is released in very large quantities requiring hours to collect. With the artificial release it is difficult also to duplicate the weather conditions prevailing during the natural flowering season.

Pollen germination and tube growth

In any breeding programme, pollen germination studies are essential for estimation of the quantity of the pollen required for controlled pollination. This information is lacking with regard to the Indian hardwoods as only a few records are available. However, pollen germination and viability of six hardwoods i.e., *Juglans regia*, *Rhododendron arboreum*, *Pyrus pashia*, *Populus deltoides*, *Populus ciliata* and *Salix tetrasperma* have been undertaken by Khurana and Khosla (1969), and some other trees by Sharma and Gaur (1984), Gaur and

Sharma (1985), and by many other workers time to time.

The pistil provides the pollen with an environment, which is most fit for the pollen germination and tube growth *in-vivo*. But certain growth regulators like boron, hormones, carbohydrates (sugars), antibiotics, extract from flowers, and irradiation are known to have stimulating effects on pollen germination and tube growth *in-vitro* (Gaur and Sharma, 1985; Sharma, 1984; Linskens, 1974), along with moisture, CO_2 and O_2 levels, temperature, pH, osmotic pressure and certain other minerals, *in-vivo* as well as *in-vitro*. The germination requirements of pollen grains differ much from species to species.

Pollen viability and longevity

Environmental factors, particularly temperature and humidity, greatly effect the pollen viability. Retention of pollen viability after shedding, varies significantly from species to species. There is a close correlation between the cytology of pollen (two or three celled) and loss of viability. Two celled pollen generally retain viability for a longer period, than three celled pollen (Brewbaker, 1957). Successful pollen storage is a very convenient tool in the hands of tree breeders for improving the trees by hybridization, occurring in different regions and also of those blooming in different seasons. Apart from pollen use in self-incompatible groups of trees, stored pollen are also used in repeating a particular cross in subsequent years with the same pollen. The longevity of pollen grains enables the introduction of new characters in trees by using stored living pollen. Thus there are many uses of pollen storage in tree improvement programmes. Poor weather conditions limit the activity of insects, and significantly reduce the yield, because of insufficient pollination. To overcome out of this problem, the tree breeders have established 'Pollen banks' through which the viable pollen of the desired species can be obtained at any time. By this contrivance, supplementary pollinations are done for genetic improvement of different trees.

Pollen sterility and Incompatibility

The knowledge of pollen sterility and incompatibility is more important to understand the pollination mechanism and breeding behaviour of the species. Selective male sterility has important practical applications and extensive work has been carried out, particularly on cytoplasmic male sterility (Edwardson, 1970.) Genic male sterility is controlled by a single gene, in most taxa, and is manifested under homozygous recessive conditions. Male fertility can easily be restored in male sterile lines by crossing the male sterile plant with a plant with homozygous dominant allels. Cytoplasmic male sterility is inherited through the female parent.

Hybrid seeds can be produced in male sterile lines by crossing them in controlled pollination conditions. Commercial production of hybrid seeds essentially depends on the prevention of self or intraline pollination in individuals used as female parent, and effective transfer of pollen from the male parent to stigmas of female parent. The use of male sterile lines has revolutionized hybrid seed production programmes as contrast to the conventional methods like emasculation, bagging and manual

pollination, which are too laborious. The mechanism of self-sterility has been worked by several workers on *Pinus* (Johnson, 1945), *Castanea* (Mc Kay, 1942), *Picea* (Langner, 1959), *Eucalyptus* (Pryor, 1957), *Pseudotsuga* (Orr-Ewing, 1957).

In incompatibility the zone of inhibition of incompatible pollen/pollen tube is generally the stigma or style. There is a close correlation between the cytology of pollen, genetics of incompatibility and the zone of inhibition (Brewbaker, 1957). The species in which pollen grains are shed at the 2-celled stage show gametophytic type of incompatibility, and the zone of inhibition is in the style. The species in which pollen grains are shed at three celled stage show sporophytic type of incompatibility and the zone of inhibition is in the stigma.

Self-incompatibility is one of the most effective outbreeding mechanisms, and is considered to be one of the main causes, for the rapid evolution of angiosperms. Besides its significance in reproductive biology of angiosperms, self-incompatibility has many other practical applications (Reimann-Phillipp, 1965).

Pollen chemistry and energetics

Variation in chemical constituents of pollen is accounted for by (i) species differences, and (ii) environmental differences during maturation and after dehiscence. During maturation excessively high temperatures tend to reduce the pollen carbohydrates, low light also results in less carbohydrates accumulating in mature pollen, probably as a direct effect of reduced photosynthesis. If the plant nutrient supply, particularly micro-elements, is below optimum, pollen mineral content may be reduced. Lower content of trace-elements in pollen can modify, the protein-enzyme levels and thus effect growth and seed set of the tree.

Wind-pollinated trees irrespective of their taxonomic position, clearly have lower pollen caloric contents than insect pollinated species (Petanidou and Vokou, 1990). The wind pollinated species produce, in general, pollen grains rich in carbohydrates (Baker and Baker, 1979). As contrast, insect pollinated species are frequently lipid rich. As lipids contain much more energy per gram than starches, lipid rich pollen would have higher energy content per unit of mass. The higher amounts of energy are required if pollen tubes have to be traverse long styles. It could be concluded, therefore, that higher energy contents of pollen from insect pollinated plants would be the result of selective pressure to secure transport of the male gametes from the anther to the ovule. The supply of their own needs and that to meet this demand, they would contain larger amount of nutrients, if the style to be traversed is longer. It can also be explained that increase energy content in pollen is evolutionarily favoured, with pollinators acting as selective agents (Lipid rich reward). If this is true it would mean that pollen energy content could increase attractiveness to pollen consumers to cover their energetic requirements. The ultimate result would be the pollination enhancement. The pollen type of wind-pollinated trees with pollen caloric contents are shown in Table 1, as proposed by Petanidou and Vokou, 1990.

Table 1

Pollen type and caloric contents of some wind-pollinated trees

Tree species	Pollen Type	Mean (± SE) Pollen Caloric Contents ($Kcalg^{-1}$ ash freed w.)
Cupressus sempervirens L.	Starchless	4.4068 ± 0.0539
Pinus halepensis Miller.	Starchy	5.4324 ± 0.0671
Acer negundo L.	Starchless	5.6075 ± 0.0677
Pistacia lentiscus L.	Mixed	5.1099 ± 0.0316
Quercus coccifera L.	Starchless	5.2584 ± 0.0584
Populus alba L.	Starchless	4.9901 ± 0.0790

Note : Starchless indicates high lipid content. $\bar{X}$=5.1342 ± 0.1711
Range : 4.4068 — 5.6075

Future prospects

Though the physiological studies on pollen behaviour have been worked out enough, but the biochemical and biophysical factors relating to its growth and development are not clearly understood. Similarly the specific needs of different tree pollens for their successful germination for different tree improvement programmes *in-vitro* conditions are not known. The pollen-pistil interaction in different environmental conditions is directly related to fertilization and is highly variable. Therefore, more studies are required to work out these phenomena. The inhibition mechanisms in self-incompatibility is a great barrier in fertilization process and the details, need to be investigated. The carbohydrates, fats, proteins and inorganic compounds present in different amounts in various grains will help in understanding the real chemical composition and the function of the grains accurately. The knowledge of Xenia and Metaxenia, pollen irradiation, cytology and crossability patterns will be of immense help in different hybridization programmes of the trees. Combination of favourable traits will help very much the forestry in producing improved varieties. The technique of gene transfer through irradiated pollen in association with techniques of *in-vitro* fertilization, seems to have great potential in transferring genes between distantly related species. It is, therefore, worthwhile to screen large number of genotypes in interspecific crosses as there is considerable genetic variation in their crossability.

SUMMARY

The inheritance pattern of the trees, is still incompletely known, therefore, more practical aspects for the tree genetic improvement and breeding programmes should be undertaken to obtain genetically better trees. The study of pollen physiology is engaging considerable attention in tree improvement programmes. The germination of pollen grains both *in-vivo* and *in-vitro*, pollen viability and longevity including storage, selective and controlled pollination, sterility its applications and incompatibility, pollen chemistry and energy contents, irradiation, crossability patterns are, therefore, discussed briefly to understand the role of pollen grains in tree genetic improvement processes.

वृक्षों के आनुवशिक परिष्कार में परागकणों का उपयोग

सी०एम० शर्मा

साराँश

वृक्षों की पितृदायिता की रूप सज्जा अभी पूरी तरह ज्ञात नहीं है इसलिए आनुवशिक दृष्टि से श्रेष्ठतर वृक्ष तैयार करने के लिए वृक्षों के आनुवशिक सुधार और प्रजनन कार्यक्रमों के व्यावहारिक पक्ष और अधिक कराने चाहिए। वृक्ष सुधार कार्यक्रमों में परागकणों की देहव्यापारिकी के अध्ययनों पर अब काफी ध्यान दिया जा रहा है। जीव में और कांच में परागकणों का अंकुरण, परागकणों की जीविष्णुता और दीर्घजीविता जिसमें भडारण, चयनित और नियन्त्रित परागण, बध्यता और इसका अनुप्रयोग तथा असयोज्यता, परागकण रसायन और ऊर्जा तत्व, विकिरण, सकरण योग्यता और रूप सज्जा भी आए हैं, यहाँ सक्षेप में विवेचित किए गए हैं ताकि वृक्षों की आनुवंशिक परिष्कार प्रक्रियाओं में परागकणों की भूमिका को अधिक अच्छा समझा जा सके।

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RESEARCH NOTE

TWIG BLIGHT DISEASE OF *CROTON TIGLIUM* CAUSED BY *COLLETOTRICHUM DEMATIUM*

Croton tiglium Linn. (family Euphorbiaceae) is a tropical herb grown extensively all over India for its uses in herbal medicine. The whole plant has medicinal property. Seeds are used as a powerful cathartic. The seed oil is well known for its remarkable purgative property which is also present in leaves and wood. It is also used as stimulant, subefacient and vesicant.

Large number of *C. tiglium* plants have been grown in the non-wood forest produce nursery at this Institute. During the survey of diseases of medicinal plants a severe twig blight disease of *C. tiglium* was observed during south-west monsoon season. Very little pathological work has so far been done on this plant. Remakrishnan (1950), Thirumalachar and Lacy (1951), Pavgi and Singh (1964), Rao (1965), Singh and Khanna (1970), and Roy (1972) have described some diseases on this host plant.

The twig blight disease makes its appearance on 2-3 years old plants during the month of July-August and persists upto September month. The infection starts from the lower surface of the leaf and gradually spreads on the twigs. The symptoms of the disease appear as ash-grey coloured well defined spots, 5-7 mm in diameter surrounded with brown to black colour ring. Acervulii are visible to the naked eye as black pustules within spots.

Morphology of the fungus shows Acervulii discoid, cushion like black, erumpent with considerable stromatic development; setae 50-120 μ in diameter and numerous, dark opaque at base, light brown at apex, upto 200 μ long and upto 7 μ thick at base; apex acute; Conidia single celled, hyaline, slightly curved to strongly falcate, smooth, one or both ends pointed, 16.5-20 μ $\times$ 2.3-3.7 μ (average 18.8 $\times$ 3.1 μ). The causal organism has been identified as *Colletotrichum dematium* (pers. ex Fr.) Grove. This is the first report of *C. dematium* on *C. tiglium* from India (Mukerji and Bhasin, 1986; Bilgrami *et al.*, 1991).

Chemical control experiment has been conducted against the disease using four fugicides viz. Bavistin, Dithane M-45, Dithane Z-78 and Captafol at 0.2% concentration. It is observed that foliar spraying of Dithane M-45 @ 2% at fortnightly interval is effective against this disease.

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Institute of Deciduous Forests,
Jabalpur
(Madhya Pradesh)

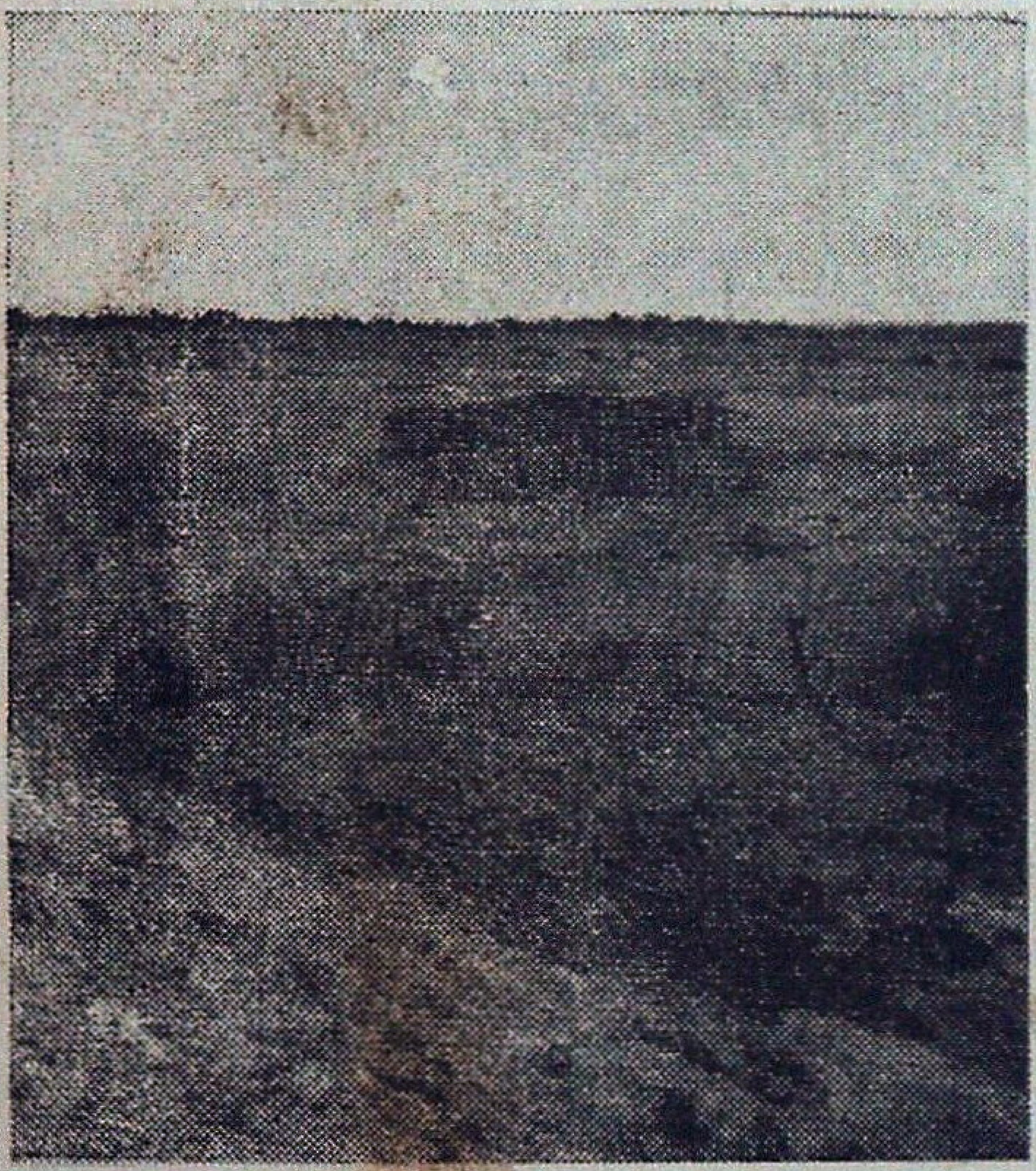
V. Nath,
Rajesh Kumar,
A.J. Asaiya
and Jamaluddin

FOREST NOTES AND OBSERVATIONS

Low cost gully treatment in Purulia District

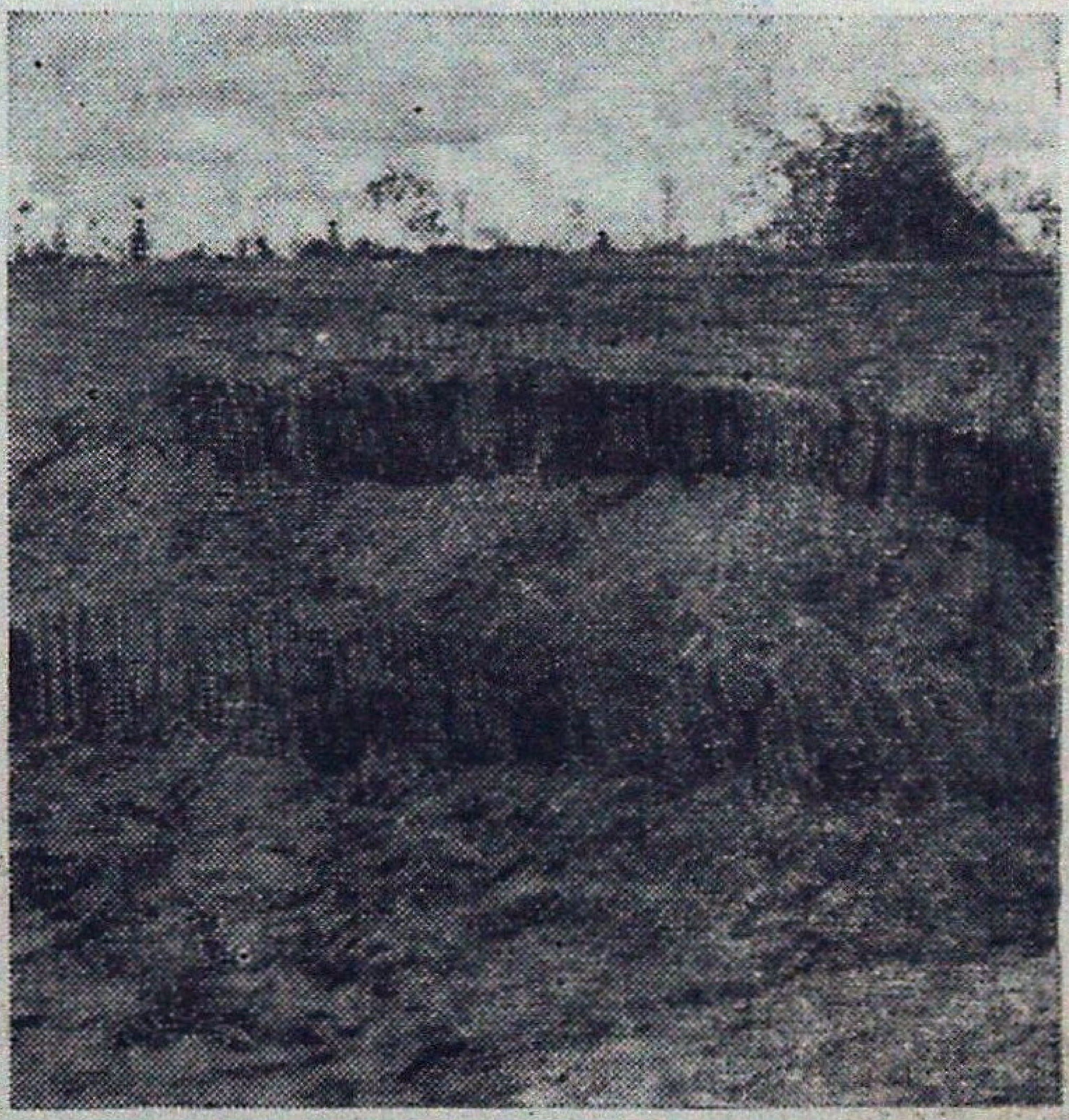
The Chhotanagpur plateau is unique for its undulating nature of the terrain. Purulia District, an integral part of plateau is therefore no exception. The terrain here, owing to such undulations and barren nature has given rise to gullies which are shallow to deep. The erosion of top soil by the action of runoff water is maximum in the gullies. Consequently gully treatment by way of plugging has become an important facet of soil conservation measures in Purulia.

Fig. 1



Bamboo stick sieve in series on eased out slope

Fig. 2



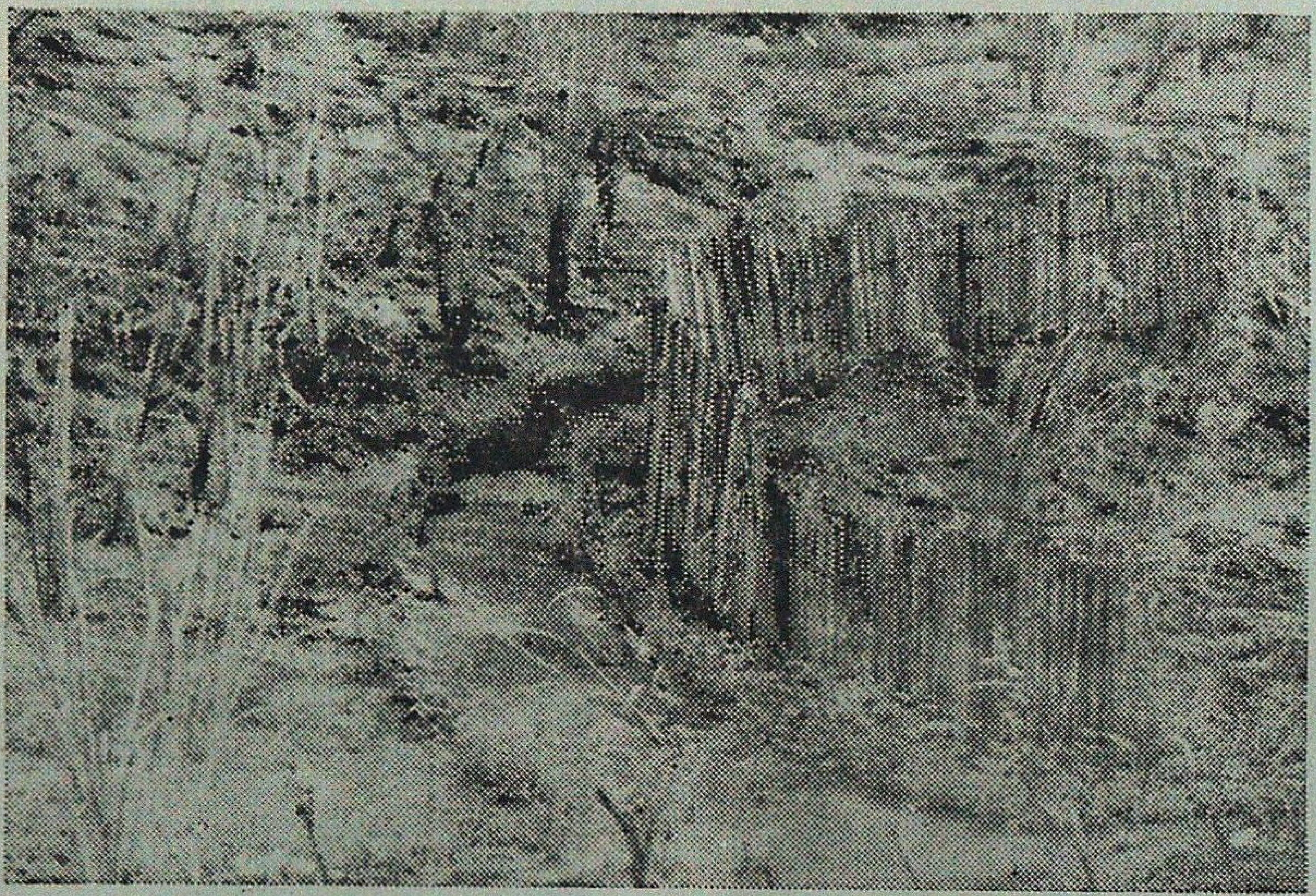
Bamboo stick sieve showing accumulation of silt

Recently, a simple method for treatment of shallow gullies of the order of 1 to 2 m depth has been designed in this district. In this method the use of bamboo sticks about half a metre in length and about 1.3 cm in breadth is used. Specifically, the vertical walls of the head and the sides of the gully is first eased out by cutting a slope of the order of 1 : 1 (vertical : horizontal). Then bamboo sticks of the dimension given above are made by splitting matured

bamboos. These bamboo sticks are then firmly introduced into the slope cut out, in a closely set manner, so as to form an elongated sieve of bamboo sticks. About 7½-10 cm of the sticks are piled into the soil and to hold them firmly the sticks are tied strongly to one another with galvanised wire.

The slope is completely covered with sieves of bamboo sticks at various levels on the slope, forming multiple sieve structure which may or may not be staggered. After a few light showers the soil carried with the runoff is seen deposited behind the sieves. The bamboo sticks are of temporary nature and after a year or so, get rotten. Therefore to give a more effective meaning to the gully stabilisation the seeds of species like *Acacia auriculiformis* (Akashmoni) or *Acacia nilotica* (Babul) or *Acacia tortilis* (Israeli babul) etc. may be sown. Also slips of soil binder grasses like *Veteveria zizanoides* may be used.

Fig. 3



Closer view of a sieve showing the growth of *Acacia nilotica* and slips of *Veteveria* Sp. on freshly accumulated silt

Purulia, having a high incidence of termite attack, it is advisable to use coaltar or aldrex on the bamboo sticks to render a little more life. Observations in Purulia showed that after the first few showers there was an accumulation of nearly 3-5 cm of eroded soil behind the seives and the seeds of *Acacia nilotica* sown during monsoons on this eroded soil germinated profusely and gained a height of about 75-90 cm within 4-5 months.

The total cost incurred in this treatment is very low. The overall cost comes out to be Rs. 11.75 to Rs. 12 50 per running metre. This includes the material cost, labour cost for splitting, and fitting the sticks and tying with wire.

Average cost break up for a metre of work of bamboo-stick sieve is as follows :

Cost of Bamboo	...	Rs. 7.00
Labour cost for splitting, piling bamboo sticks, tying with wire, sowing seeds and repairs	...	Rs. 3.60
Cost of galvanised wire and seeds of *Acacia nilotica*	...	Rs. 1.15
Total	...	Rs. 11.75

S. Barari*,
Divisional Forest Officer,
Kangsabati Soil Conservation Division–I,
Purulia (West Bengal)

* Presently D.F.O. Silviculture (South) Division, Midnapore (West Bengal).

From the Indian Forester—One Hundred Years Ago

THE INDIAN FORESTER

July, 1892 (pp. 269-272)

ANNUAL FOREST ADMINISTRATION

Reports of Bengal, Ajmere and the Andamans for 1890-91.

These have only just been received and are so late that we need not refer to them at great length. Of the Bengal Government Review we have long ago (Vol. XVII) given an account, though we had not then the Report itself to hand. Under a new system, all these Reports are kept back in the Press until everybody has had his say and then they are issued. It may be cheaper to the Government and more convenient for the Secretariats who get advance copies, but to outsiders it results in their issue at a time when nearly all interest in what they may contain has ceased.

The most noticeable feature of the *Bengal* Report is the Chapter on Establishment, which shews the results of the attempt to turn Bengali Baboos into useful Forest Subordinates. Of eight Bengalis sent to the Forest School for training in the past seven years, there are now practically only three left in the service, the others having all resigned or remained away on sick leave, while among the rest of the staff, prosecutions have been numerous. There is some reason to think that much of this result is due to the bad prospects held out, and the practice of putting young Europeans or Eurasians into the Department over the heads of the natives, for we believe that Assam has secured better Bengali Officers by giving better prospects and promotion; but, at the same time, there can be little doubt but that Bengalis are not much more suited for Forest Work than they are for soldiering. Sir Charles Elliot thinks that a remedy may be found in encouraging athletic exercises in schools and colleges, and the Government of India very properly decide not to give up quite yet, but to await the results of improved prospects. We believe that, although of no use as combatants, Bengali gentlemen have done excellent work on frontier and other expeditious where quite as much hardship and malaria are to be met with as in the forests, in the Medical and Commissariat and Transport Departments, and we think that with better promotion and better prospects, better men will come forward and especially those from the Dacca and other Eastern Districts, where likely candidates may more probably be found than in those nearer the Presidency. Mr. E.P. Dansey has set to work with great energy in Bengal and we are sure the sad state of the staff which his report discloses will soon be changed into the efficiency which ought to come under such a Government as that of the Lower Provinces.

In the *Ajmere* Report the only noticeable feature is the strong disapproval which the Government of India have expressed of the policy which the Local Government has lately adopted in respect to grazing and fodder supply. The Ajmere Reserves, about the poorest of the forest areas of Northern India, were taken up, we believe, after considerable trouble, under the advice of Mr. A.O. Hume and Sir D. Brandis; and for a considerable time were very carefully protected, with the result of great improvement in growth, not only of trees but of fodder supply. Lately, as forcibly shewn by Mr. Hill in his special report, much of the good work done has been nullified by a too early re opening to grazing and hence the remark of the Government of India, strong for them, that *except as regards the treatment of the fodder resources*, they consider the administration satisfactory. As everything in Ajmere depends on the grazing question, the importance of this remark cannot be underrated. We extract the following important expression of opinion from the Government of India Review.

"The time allowed for the cutting of grass within reserves was reduced from four months to one month in order to meet the expected scarcity of fodder throughout the country by throwing the state forests open to grazing. This action has involved a change not only of practice, but of policy also.

From the year of the great famine, 1878-79, it has been the aim of the local administration to promote, on Government lands at any rate, the cutting of grass, and to reduce grazing within the narrowest limits; as the result of this continuous policy, the annual outturn of cut grass had steadily increased from 740,000 bundles in 1884-85 to 1,692,000 bundles in 1889-90.

This fact was accepted as an indication that the people had begun to understand and appreciate the true advantages of a conservative treatment of the fodder-resources of the country, and some disappointment has therefore been felt that, in the year under review, it should have been thought advisable to abandon what is held to be the more economical method of reaping a grasscrop, in favour of grazing. The circumstance that general scarcity of fodder was expected would, if the policy hitherto advocated is sound, have justified a closer exclusion of cattle from the reserves, rather than their unrestricted admission while grass fit for the sickle was still on the ground. The outturn in cut-grass decreased from 1,692,092 to 304,000 bundles, or to 18 per cent of last year's yield.

It is at the same time admitted that on forest pastures, especially where the arbori-vegetation consists to a great extent of scrub, there will always be found growing amongst thorns, a certain quantity of grass which cannot profitably be removed by hand, but will be searched for and grazed out by hungry cattle. With this fact in view Governor General in Council has no objection to the proposal made in paragraph 4 of your letter No. 1227 S., dated the 13th June 1891, that such reserves should be thrown open to graring in years of marked scarcity, provided that such action be not taken until after the removal of such fodder as can profitably be cut by hand.

But His Excellency in Council cannot approve of the suggestion made by Colonel Biddulph, that all reserves, not specially selected for the production of timber and fuel, should be thrown open annually to grazing, subject only to a limitation of the number of cattle admissible to each block. The reserves do not appear to be either extensive or productive enough to justify a system of treatment which is held to be the least economical, and which would interrupt the progress of a policy which appears to the Government of India to be calculated to secure the fullest results.

We should like to hear something about the system of planting which has given such favourable results. It is recorded that "the plants were put down in the ground in earthen pots (or gamlas) which protected them against the ravages of wild rats and the attacks of white ants, and also gave them the full benefit of the water given to them". Planting trees in flower pots and then putting pot and all in the ground is a strange way of raising a forest. What do the roots do when they have filled the pot ?

The *Andamans*' Report we have read with much interest, for though it contains very little of sylvicultural interest, there is evidence of a considerable development of the trade in timber from the Islands, which is gradually introducing new woods of value into the Home and Indian markets.

There are three chief markets for the Andamans timber, those of London, Calcutta and Madras. The woods sent to London were chiefly 'Padouk' (*Pterocarpus indicus*) in squares and planks and the rate of sale, after allowing for exchange, &.c., was apparently, on an average, Rs. 1-12 per cubic foot, but it is noticeable that Woolwich Arsenal took some of the timber at 4s. 6d. To Calcutta, the consignments consisted chiefly of Padouk, 'Lakuch' (*Artocarpus lakoocha*), 'Toungpeing-nge' (*Artocarpus chaplasha*), 'Thitmin' (*Podocarpus latifolia*), Marble wood (*Diospyros kurzii*), 'Koko' (*Albizzia lebbek*) and 'Gurjun' (*Dipterocarpus alatus*) and the price received came all round to a little over one rupee per cubic foot, The same result was obtained from the sales in Madras, to which place the same species were sent as well as some 'Pyinma' (*Lagerstromia hypoleuca*), 'Gangow' (*Mesua ferrea*), 'Thingun' (*Hopea odorata*) and 'Chugiam' (*Myristicu irya*), (we hope our identifications are correct—we insert them as it can hardly be expected that our readers at home or in other parts of India, will recognize what is meant by the Andamans names). The extraction of this timber is carried on by Elephant dragging and a tramway, and its cost has been considerably reduced by the establishment of the latter.

Sylviculturally, the only noticeable matter is the discovery that by opening out the canopy round padouk standards, it is possible to secure a good advance growth.

The Government of India, acting on the recommendations of Mr. Hill's Report, have recommended the immediate commencement of a detailed examination of the padouk forests and the preparation of working plans for their management.

LETTERS TO THE EDITOR
(I)

To,

The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.).

Sub : **Reports on the insectivorous food habits of striped squirrels.**

Dear Sir,

The visual observations of Shri Raza Tehsin of Udaipur published in the Letters to the Editor column of June 1991 issue of the *Indian Forester* not only add to the knowledge on the food habits of *Funambulus pennanti*, but also supports the earlier observations of Krishnaswami and Chowhan (1957, *J. Bombay Nat. Hist. Soc* **54** : 457-459), Agrawal (1965, *J. Bengal Nat. Hist. Soc.* **34** : 76-83) and Sood Dilber (1977, *Journal of Research*, **14** : 329-331) who reported the insectivorous habits of this squirrel from the stomach content identification.

In this context I would like to mention that Bhat and Mathew (1985, *J. Bombay Nat. Hist. Soc.* **82** : 637-642) have reported that the Western Ghats squirrel, *Funambulus tristriatus* Waterhouse found in the Western Ghat biome of the Indian peninsula is also an active predator of termites. The authors also reported that more than 90% of the squirrels they observed had taken termites as one the food items. Apart from several plant materials black ants, beetles, caterpillars, grubs and scale insects were also listed as the food items of these squirrels. Hence, it is to be noted that the striped squirrels are omnivorous in their food habits.

Yours faithfully,

Sd/- S. Keshava Bhat
Rodent Biology, CPCRI,
Kasaragod (Kerala)

———

(II)

To,

The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Dear Sir,

The issues raised by Shri A.K. Mukerji in his article "Causes for ecological degradation in Himachal Pradesh—Need for rehabilitation" (*Indian Forester*, June, '91) are very relevant to Tripura as well. The pace of deforestation has been much too fast in this predominantly hilly state losing about 2% of forest cover per year. Only around 25% of the total area is available for agriculture, and the per capita land is as low as 0.38 ha (Forest 0.19 ha, others including agriculture 0.19 ha). Situational constraints, poor communication and lack of infrastructural development inhibit the possibility of significant industrial growth. The demands of the people on the remnants of the forest, for whatever it can give, will therefore continue, and can not be wished away.

It is in this context that Shri Mukerji's prescription, for integrated area development approach in collaboration with the local people and with forestry and soil conservation in wastelands as the core sector, demands serious attention. The problems of deforestation, ecological degradation, reduction in agricultural productivity, lack of employment opportunities etc. as pointed out by Shri Mukerji, are significantly interrelated and particularly so in a hilly area like Tripura. But could we organise a "qualified multi-disciplinary technical team" under the governmental set up to effectively survey, plan and implement programmes of the kind ? Or, should we involve responsible NGOs and Voluntary Agencies for such survey, assessment and planning by giving the adequate financial assistance ? Even technical assistance could be provided by making the services of scientists and technocrats in the Govt. employ available to them for the purpose. As for the implementation, we have to decide whether to entrust the same to Governmental agencies, or alternatively allow the Village Panchayets to manage such programmes under the guidance and control of the NGOs or Voluntary agencies involved earlier for the planning. Appraisal could be taken up with all seriousness through independent agencies.

Problems will vary depending on the political environment, economic background and social and cultural ethos of the people as also the physical status of the land and other natural resources. The approach and even the choice of technology and other details may vary accordingly. It may be desirable to take up some experiments in the shape of Pilot Projects in the various regions including the North-East. Results of such experiments can only show us whether elected bodies can be motivated through NGOs and Voluntary Agencies to ensure proper implementation of such area development programmes in a more responsible manner compared to Govt. Agencies. It will also be possible to compare the overhead costs with similar programmes implemented directly through Govt. Agencies.

There is a growing realisation that the management of our natural resources for optimum production at sustained levels may be possible in our country only through active participation of the people both at the planning as well as in the implementation levels. But, the people have to be organised, motivated and trained by professionals of diverse disciplines and social workers to make such participation possible. It is in this area that the Forest Departments as also the other development deptts. should now concentrate more and gain expertise.

Yours faithfully,

Sd/- A.K. Sinha
Divisional Forest Officer,
Forest Research Division,
Agartala (Tripura)

———

(III)

To,

The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Sub : **Clarification on the article "Use of intensive soil working technique in afforestation of wastelands" by Shri V.R. Singh–*Indian Forester* July, 1991**

Sir,

I have gone through the said interesting article. The efforts of the author deserve commendation from all quarters.

In this connection, the following clarifications are sought for the benefit of all the foresters who may be interested.

(1) While it is stated that the technique is suitable only for the plain areas, it has been prescribed that contour planting was carried out at the spacement of 2 m × 2.25 m. For comparison purpose contour trench method has also been tried over 16 ha of land. Should it be presumed that the terrain has gentle undulations ! The velocity of flow of water as well as top soil would depend on the degree of the slope. It is, therefore, essential to indicate ruling gradient of the slopes.

(2) In item 2 of the 'recommendations', it is recommended to soak the poly-potted seedlings with root promoting hormone. Quantity of Seredax may please be specified by weight.

(3) It is also not clear if the dose of root promoting hormone recommended was applied for the experiment. In case it was so, it should be stated whether this application was uniform for all the three models of planting or not since this is considered pertinent variable for this research.

It would be immensely helpful for planters who deals with similar wasteland if the appropriate branch of any research institute takes up the cue provided by this author.

Yours faithfully,

Sd/- S. Bose
Director (Plantation)
Orissa Forest Dev. Corpn. Ltd;
Bhubaneshwar (Orissa)

REVIEWS

(I)

"Forestry Service Structure in India" published by Society of Indian Forester, New Forest, Dehra Dun. Price Rs. 225/-

This is the second in the series of books on forests, foresters and forestry published by the SIF. On the same lines as that of its preceding publication, 'Forestry Education and Training in India' (SIF, 1989), the present publication is a compilation of papers, presented by a mix of old and young foresters and scientists, at the seminar on the subject, held during April, 1990. The papers, which have been grouped under three parts, namely, forestry orgn. in India, top requirement & trg. of foresters, and Cadres and training for specialised jobs, provide a vivid insight to the structure of the forest service, its changing responsibilities and suggestions for review of existing structures. The experience of heads of forestry organisations in the States, as well as that of younger officers currently concerned with education and training of foresters at all levels, has been put to good use in preparation of the papers. Though the papers present personal views and suggestions only, administrators and policy makers can gainfully draw ideas from the compilation The Editors would have done well to also include gists of discussions and proposals of some of the other 125 odd participants, who did not present papers, in the form of a last chapter.

The book will prove useful to policy makers, educationists and historians, who will find plenty of hitherto unpublished material at one place.

P.K.

(II)

"The flora of Sawantwadi" by S.M. Almeida, published by M/s. Scientific Publishers, Jodhpur, Vols. I and II, pp. xiv+411 and 304. Price Rs. 600/- or $ 120-00.

These two volumes are the outcome of seven years (1976-83) of intensive exploration of species of Sawantwadi of Maharashtra State. The first volume contains introduction, key to vascular plant families, description of plants Ranunculaceae to Araucariaceae and the second volume, Hydrocharitaceae to Poaceae; pteridophytes, bibliography, and index to local and botanical names.

The flora deals with 1350 taxa, 1685 species of vascular plants including ferns. The volumes also incorporate 5 new taxa, 60 new distributional records of Maharashtra State with corrections in the plant nomenclature. The genera and species are arranged in alphabatical order for easy references. 6 colour plates, 2 maps and 4 line drawings have also been incorporated.

These volumes would be a valuable reference source for researchers, foresters, teachers, students and to all interested in floras.

B.S.B.

NEWS AND NOTES

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Forestry Department Headquarters,
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Jalan Sultan Salahuddin,
50660 Kuala Lumpur (Malaysia).

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

Shri Hitesh Malhotra, IFS., handed over charge of the post of Field Director, Project Tiger, Srisailam to Shri L. Krishna Bhoopal Rao, IFS., Conservator of Forests, Hyderabad Circle, Hyderabad on the afternoon of 13.4.1992.

Shri L. Krishna Bhoopal Rao, IFS., has taken full additional charge of the post of Field Director, Project Tiger, Srisailam on the afternoon of 13.4.1992.

KARNATAKA GAZETTE

Shri Shivanna Gowda, IFS. (RR-1980), Deputy Conservator of Forests, waiting for orders of posting is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Yellapur Division, Yellapur vice Shri K. Ramakrishna, IFS, transferred.

Shri K. Ramakrishna, IFS. (SFS-1985), Deputy Conservator of Forests, Yellapur Division, Yellapur, is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Shimoga Division, Shimoga, vice Shri G.V. Sugur, IFS, deputed for training abroad.

Shri V. Sathyapal, IFS (SFS) under orders of posting as Deputy Conservator of Forests, Zilla Parishad, Gulbarga is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Chitradurga.

The posting of Shri M.S. Gowder, IFS (RR-84) as Deputy Conservator of Forests, Chitradurga stands cancelled.

WEST BENGAL GAZETTE

Shri V. Rishi, I.F.S. assumed the charge of the office of the Conservator of Forests, Soil Conservation (North) Circle, West Bengal with headquarters at Siliguri on the forenoon of 30th April, 1992.

———

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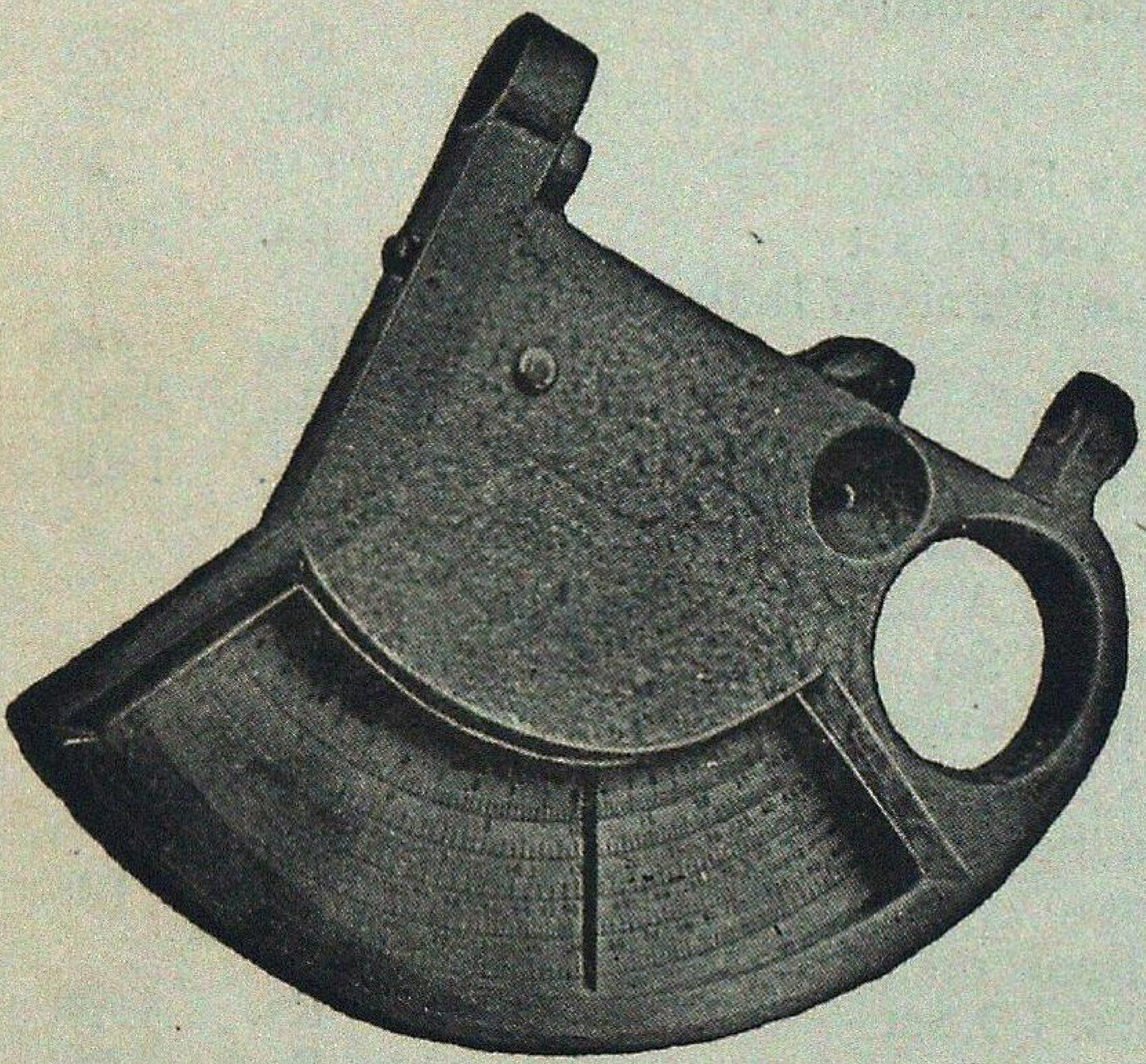

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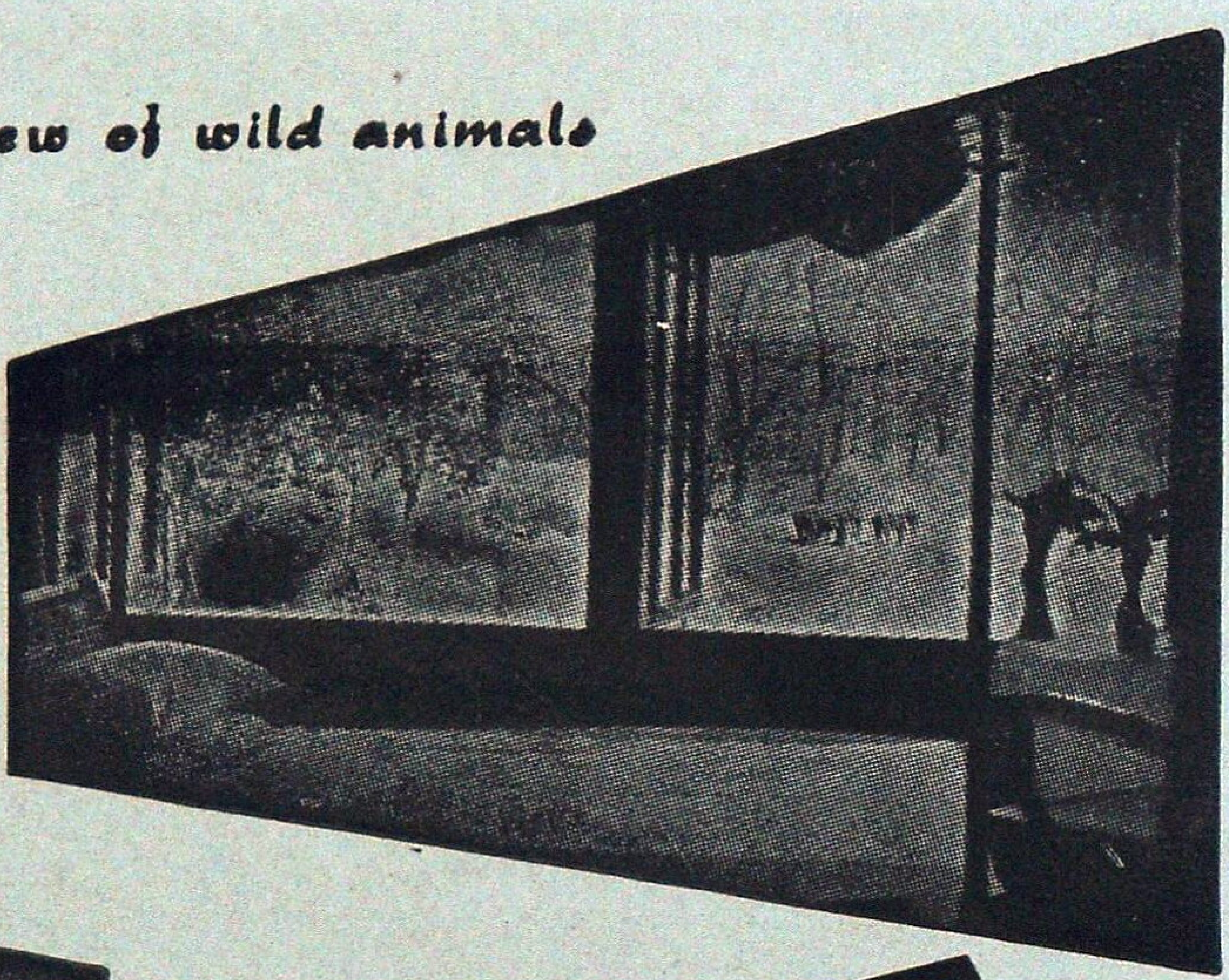

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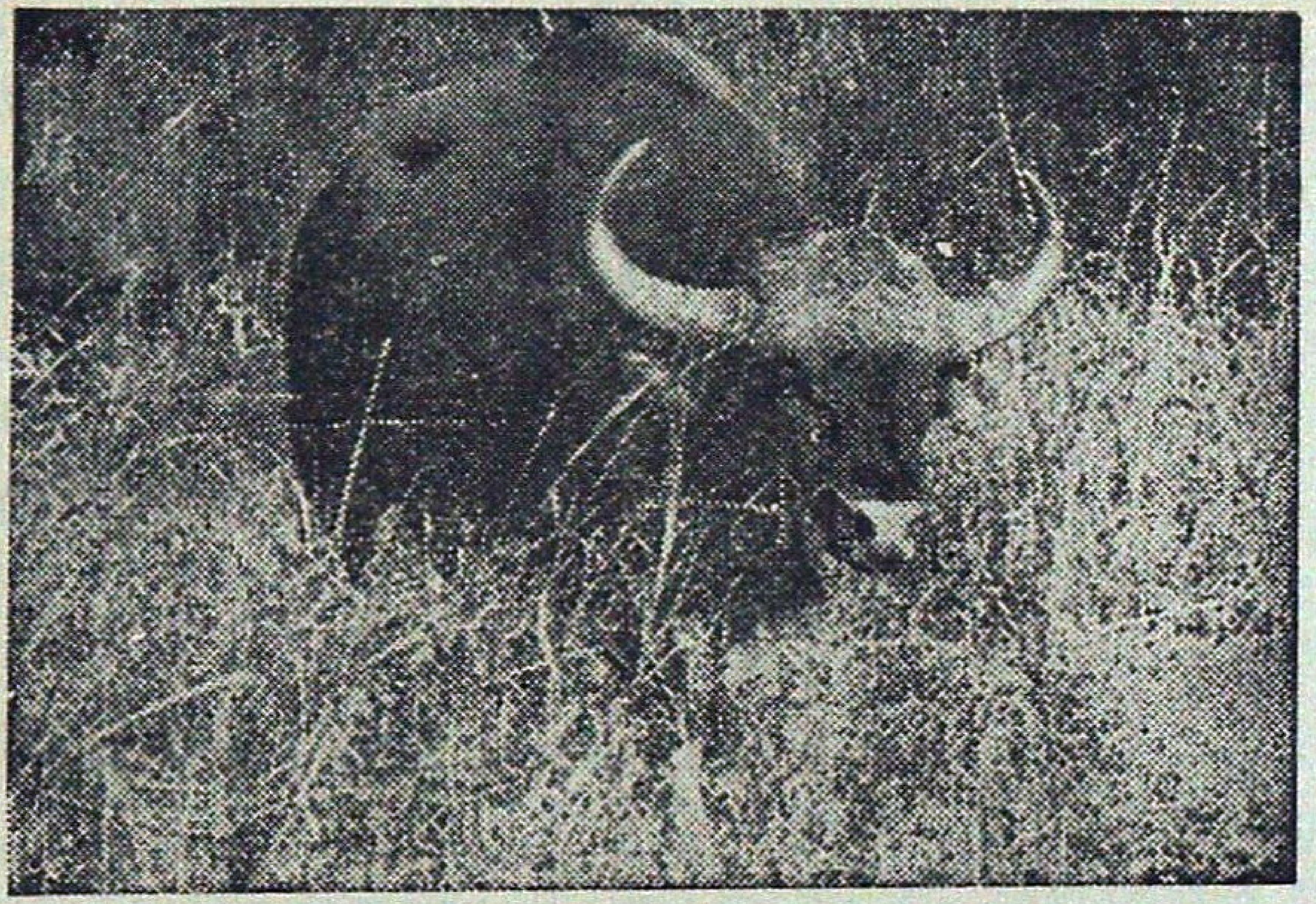

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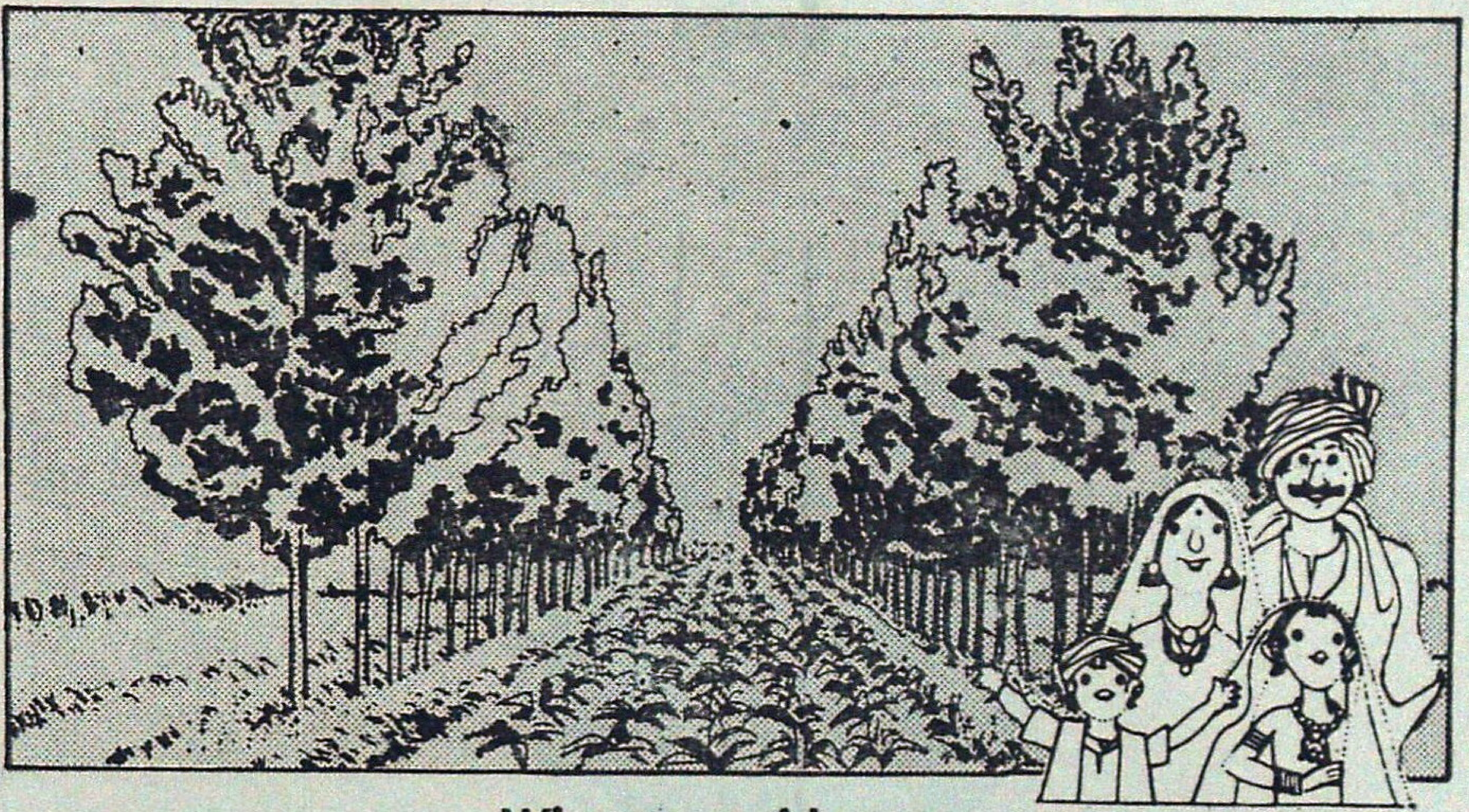

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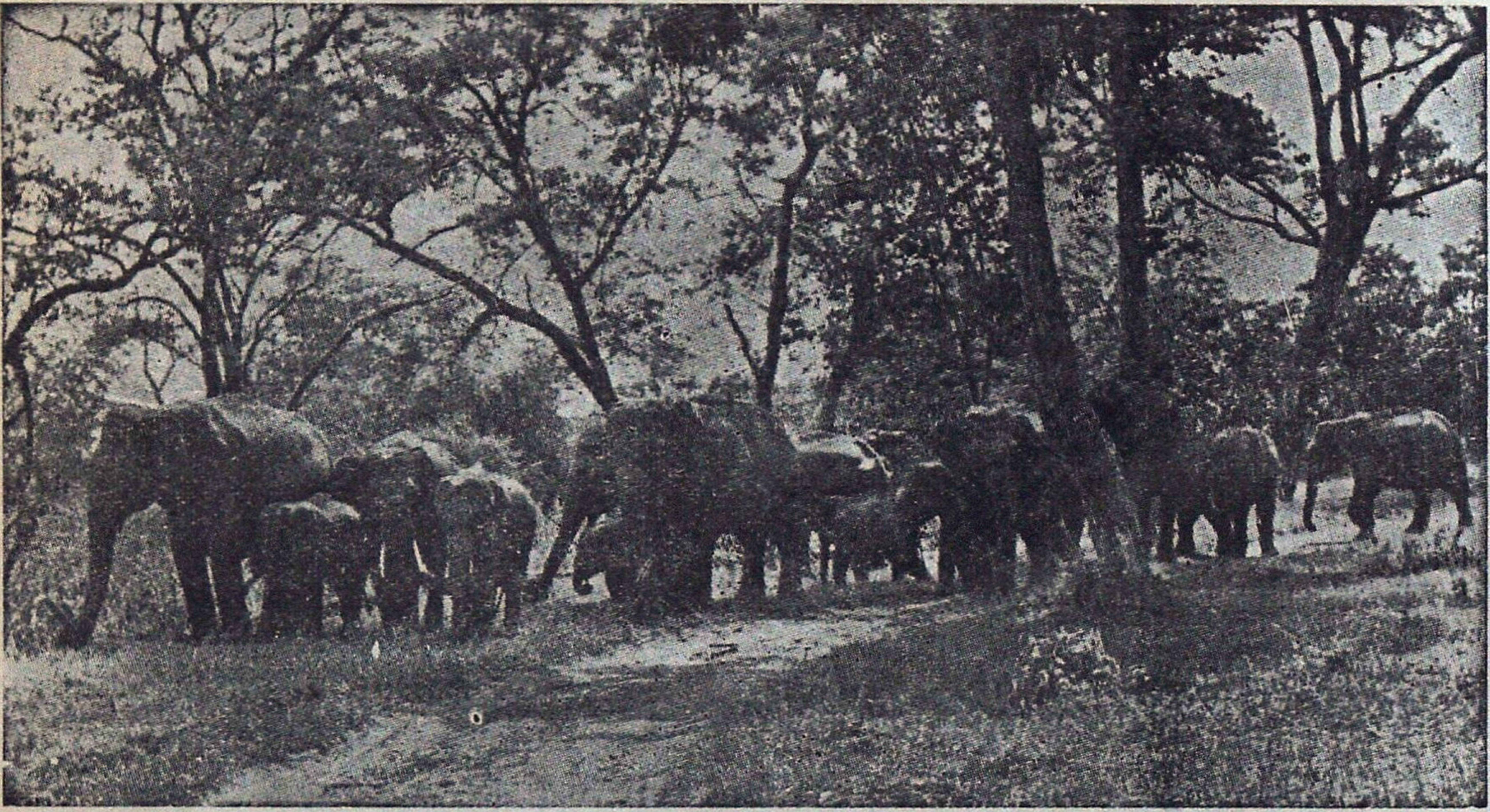

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Published by B.S. Beniwal, I.F.S. (Asstt. Silviculturist, Gen.) from Forest Research Institute, Dehra Dun on behalf of the Board of Management, Indian Forester, Dehra Dun. Printed by S.K. Arora at Print World, 29-Rajpur Road, Dehra Dun. Hony. Editor: Pankaj Khullar, I.F.S. (Director, Silviculture Research, Forest Research Institute, Dehra Dun).

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